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The Institute of Vitreous Enamellers
The Welsh Engineers' and Founders' Association
The Foundry Trades' Equipment and Supplies Association

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Foundry Technology in America

There is insufficient recognition in Europe of the debt owing to the American Foundrymen's Association for the leadership it has invariably given since its formation more than forty years ago in the technical advancement of foundry practice. Its successful launching by Mr. John A. Penton and the late Dr. Moldenke was quickly recognised by the more progressive foundrymen of the United Kingdom, and the formation in 1904 of the Institute of British Foundrymen (originally the British Foundrymen's Association) was a direct result therefrom. Although the United States are as old, industrially, as any other country, it has generally been the case that they have modelled their professional organisations along the lines of the earlier British ones, but so far as foundry practice is concerned, it must be conceded that they were the pioneers. Not only in the creation of technical organisation were they the first in the field but also in most of the activities now generally associated with foundry technical institutions, except perhaps for the creation of Branches and a pure research body such as the United Kingdom possesses in the British Cast Iron Research Association.

Perhaps, because of the great distances between the foundry centres in the American continent, it was originally found necessary to supplement the benefits derived from the annual conferences by the formation of numerous committees and sub-committees. To such an extent has this activity grown that the last list to arrive here contains no fewer than 131 entries, including those relating to the official A.F.A. representatives on the committees of other bodies. To staff these committees 282 members hold office. As the executive staff of the A.F.A. consists of only five people, the organisation is a fine testimonial to voluntary effort. A few years ago, the Association undoubtedly felt the need for local activities in order to benefit those who found themselves unable to attend the annual congresses except on rare occasions. With thoroughness and commendable energy, the officers initiated a continent-wide compaign. In some cities local associations existed, and these had to be converted into Branches or "Chapters" as they are known in America, whilst elsewhere new ground had to be broken. The result is that now there are no fewer than eighteen Chapters.

For social gatherings, it is not uncommon to read that 500 persons were present, and at a Christmas party held in Cleveland the muster exceeded 750—a larger number than any foundry gathering—even international—ever held in this country! As the membership of the Association is of the order of 3,000, the support of its members must be exceptionally enthusiastic.

The work sponsored by the Association is a model of what can be done by a technical institute as distinct from a research association. It has consistently made efforts to bring before its members any fresh developments by means of exhibitions and technical sessions. The assembly in Report form of data on particular subjects, such as sand testing, costing, the properties of cast metals, and the like, has been particularly effective in creating utilisable yardsticks within the industry, on the one hand, and popularising its products with potential customers on the other. Perhaps the latter activity ought to be undertaken, or at least paid for, by the employers' federations. Yet, if benefit accrues to the industry, it is immaterial in the long run who foots the bill. That benefit has resulted to the American foundry industry from the publication of the Cast Metals Handbook is undeniable, and a similar effect is confidently expected from the newer one, "Alloy Cast Irons." Pure research work, such as that dealing with the behaviour of refractories at high temperatures, is being sponsored by the Association at the Battelle Institute. The early results are of exceptional interest, but whatever the outcome, American methods are such that the findings will finally be reduced to such simple terms that the practical man will be in a position to apply them with advantage to his own practice.

In international co-operation, despite relative remoteness, the A.F.A. have been most enthusiastic, and we are well aware that there are many American foundrymen who owe the Nazis a grudge for having spoilt their plans for participating in last year's International Congress. Since the inception of the scheme for the international exchange of technical Papers, we estimate that the American contributions must now number close upon one hundred, constituting in themselves a valuable compendium of foundry technology.

The personnel of the United Kingdom foundry industry is both cognisant and appreciative of the very substantial help which has been given to it by the Institute of British Foundrymen, and it is desirable that it should be made aware of just what it owes to the influence, example and assistance emanating from the American Foundrymen's Association.

C

Institute of British Foundrymen

ELECTION OF NEW MEMBERS

At a meeting of the Council of the Institute of British Foundrymen, held in London on January 20, the following were elected to the various grades of membership:—

As Subscribing Firm Members

Magnesium Metal Corporation, Limited, Port Tennant Works, Swansea (representative, T. D. Rees, M.Sc., research metallurgist); Sorbo-Mat Process Engineers, consulting foundry engineers, 1,435, Syndicate Trust Building, St. Louis, Missouri, U.S.A. (representative, J. J. Picco, research engineer); South African Iron & Steel Industrial Corporation, "Iscor," Pretoria West, South Africa (representative, O. J. Hansen).

As Members

A. B. Anderson, works manager, Central Engineering Works, Johannesburg, S.A.; J. Augstein, works manager, Leinster Square, London, W.2; W. J. Bagg, foreman brass moulder, Brecknell, Willis & Company, Limited, Bristol; J. Bolton, foundry manager, J. Walton & Son (Nelson), Limited, Nelson; H. Booth, assistant sales manager, Leigh & Sillavan, Limited, Manchester; J. H. Gray, director, J. Gray & Sons, Limited, London, S.W.1; H. Holdsworth, foundry manager, Eclipse Tube Mill Liners (Prop.), Limited, Benoni, S.A.; D. Neustadter, consulting engineer, Constructional Engineering Company, Limited, Birmingham; J. C. Roche, secretary, Constructional Engineering Company, Limited, Birmingham; W. C. Smith, pig-iron salesman, Staveley Coal & Iron Company, Limited, near Chesterfield; T. Spedding, chief draughtsman, Stokes Castings, Limited, Mansfield.

As Associate Members

H. Alexander, foreman patternmaker, Renold & Coventry Chain Company, Limited, Manchester; R. Baxter, assistant chemist, J. Lang & Sons, Limited, Johnstone; Wm. Bell, moulder, Rolls-Royce, Limited, Hillington, Glasgow; H. T. Bonehill, foundry foreman, Idoson Motor Cylinder Company, Limited, Smethwick; G. Brown, laboratory assistant, Smethwick; L. L. Cox, patternmaker, Rolls-Royce, Limited, Derby; W. C. Cresswell, ironfoundry foreman, E. Wilkes, engineer and ironfounder, Pelsall; G. Distin, founder, Plymouth; J. Garlick, foreman patternmaker, Ferranti, Limited, Hollinwood; R. Grundy, foundry foreman, Asa Lees & Company, Limited, Oldham; H. Hallas, patternmaker, Huddersfield; F. K. Howlett, assistant metallurgist, W. Mills, Limited, Birmingham; A. J. Hunt, foreman, Morgan Crucible Company, Limited, London; G. D. Mitchell, patternmaker, Hyde, Cheshire; J. C. Prior, foreman patternmaker, Dunswart Iron & Steel Works, Benoni, S.A.; L. Rogers, foreman moulder, Derby; H. Smith, jun., assistant works manager, Falkirk Iron Company, Limited, Falkirk; P. Smith, foreman patternmaker, Sentinel Waggon Works, Shrewsbury; R. Wainwright, draughtsman, English Steel Corporation, Limited, Sheffield; L. R. Warner, foreman, Indian Iron & Steel Company, Limited, Kulti, Bengal; J. L. Watts, iron moulder, Condor Ironworks, Limited, Oldham; C. W. White, coremaker, Ley's Malleable Castings Company, Limited, Derby; J. Wright, foreman ironmoulder, Coltness Iron Company, Limited, Glasgow; A. N. Wyers, metallurgical chemist, Midland Motor Cylinder Company, Limited, Smethwick.

MR. PERCY ALDER, a director of J. G. & P. E. Alder, Limited, engineers, of Newcastle-upon-Tyne, has died, aged 67.

Correspondence

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

Monolithic Linings for Cupolas

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—As the pioneer of rammed long-life cupola linings I was very interested in all Mr. Oldershaw had to say, but from two points he mentioned, I rather think he has not been using the best composition for fixing a really long-life monolithic lining.

I have personally supervised cupola ramming in Germany, Sweden, Spain, France, Canada and the United States but have never used a cupola ramming material which could be put down with "windy" rammers. When I say "long life" I mean a lining that will stand for upwards of ten years such as one I examined last week. This particular lining was rammed in 1929 and although more than 95,000 tons of extremely hot iron have been melted in this furnace the lining is as good to-day as when it was first installed by me.

Incidentally, it may be interesting to record that the first ramming I supervised was in Bradford in 1915, and that lining stood for seven years.

The second point is the question of vitrification. If a lining of six inches or more vitrifies right through then a short life is a certainty, since vitrification is actually fusing. A long-life lining vitrifies only on the surface yet is mechanically strong right through.—Yours, etc.,

T. H. GRAY.

"Isebrook,"
Polwell Lane,
Barton Seagrave,
Kettering.
January 22, 1940.

From Sir Arrol Moir, Bt.

Wartime Inventions

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—During the last war invention was one of the key industries of the country, and is still more so to-day, both for the promotion of victory and for the speedy revival of trade afterwards. I am anxious to make it known, therefore, that inventors with ideas of any kind, either for the fighting Services or for peacetime trade, will be given full support by the Institute of Patentees if they will apply by letter and state the nature of their work.

Our object is to collect "war" and other inventions which may be of use to the country and launch them by submission to the proper authorities and firms, as this organisation has for its primary purpose the protection of inventions, and we are ready to give inventors every assistance in carrying out their aims of national importance. Inventions of any kind, however simple, are welcome, and they will receive the earnest attention of a competent technical committee.—Yours, etc.,

A. MOIR
(Vice-President, Institute of Patentees).
10, Victoria Street,
Westminster, London, S.W.1.

Book Review

The Mechanical World Year Book, 1940. Published by Emmott & Company, Limited, 31, King Street West, Manchester, 3. Price 1s. 6d. net.

No material changes have been made in the sections dealing with cast iron, as these were brought up to date only a year or two ago. This year the index has been revised and improved—an important matter for a handbook. All the usual features have been retained and its usefulness well maintained.

Random Shots

The presentation of a wristlet watch to Mr. T. Makemson as a mark of appreciation for the success he made of the International Foundry Congress last June, reminds "Marksman" of the story of the little Manchester boy who was evacuated to a large country house in Cheshire. His eyes grew large and round with amazement as he was received into the imposing hall.

"My!" he exclaimed in wonderment, "If I'd known I was coming to such a nice house, I'd have brought my watch!"

* * *

It was not just one of those remarkable coincidences that sometimes happen in life which caused it to fall to the lot of Mr. D. H. Wood, himself so recently married, to announce that Mr. Makemson had been doing a little domestic refurnishing out of the same gift. Mr. Makemson is not getting married, and those who have been trying to find an attractive girl for him in every European capital (especially Paris), for years, are doomed to disappointment. Like the singer of the old refrain which goes, "It cost me seven and sixpence, it cost me seven and sixpence, and I wish I'd bought a dog," Mr. Makemson prefers the quieter animal. And has, in fact, just bought himself a dog!

* * *

The present state of civilisation! "Hurrah," shouted one of the survivors of a mined ship, adrift in a small boat, "we are nearing civilisation. There are two bombers in sight."

* * *

A young scholar was asked in a geography test to name the capitals of certain countries. "The capital of Bulgaria," he wrote, "is Chesterfield."

"Why Chesterfield?" asked the puzzled teacher. "That is a little town known only for its crooked spire. The capital of Bulgaria is Sofia."

"Oh, yes," replied the scholar, "I knew it had something to do with settees!"

* * *

"Swedes to help the Finns," reads a headline. And the Finns hope that they will turnip on a large scale!

"MARKSMAN."

Diploma Awards for Foundry Congress Papers

The Council of the Institute of British Foundrymen has decided to award diplomas of the Institute to six members for Papers which they presented to the recent International Foundry Congress held in London. The recipients of these awards are as follow:—

Mr. J. J. Sheehan, for a Paper on "Core Shop Control."

Mr. A. J. Murphy, for a Paper presented jointly with Mr. S. A. E. Wells and Mr. R. J. M. Payne, on "The Effect of Melting Conditions on Light Alloys."

Mr. G. L. Bailey, for a Paper on "The Effect of Melting Conditions on Gas Unsoundness in Metals."

Mr. G. R. Shotton, for a Paper on "Some Notes on the Design and Operation of the Open-Hearth Furnace for Melting Malleable Cast Iron."

Mr. F. A. Melmoth, for a Paper on "The Renaissance of the Steel Casting and the Rôle of the Metallurgist."

Mr. A. H. Guy, for a Paper on "Industrial Legislation in South Africa."

Cupola-Melted High-Duty Cast Iron*

By H. W. GILLETT and C. H. LORIG (Battelle Memorial Institute)

The signs of the times indicate that the foundryman will be under increasing customer-pressure to supply high-duty and alloy irons. Or, if this phraseology is not agreed with, it perhaps could be stated that the foundryman who can produce high-duty irons has a product which he can merchandise, one that opens up a field of service that cannot be entered by the foundryman who can make nothing but soft grey iron.

It has been estimated[1] that 10 per cent. of the total American grey iron output of 1937 was alloyed, and it might be expected that an equal amount of unalloyed high-duty iron was produced. Every sign, including the hearty reception given the American Foundrymen's Association Handbook on Alloy Cast Iron, leads to the conclusion that, and very soon, somewhere between one-fourth and one-third of the grey iron output will be some variety of high-duty iron. The attention being given in England[2] to high-duty iron is an additional straw in the wind. The foundryman who can only supply the garden varieties of iron will find his sales outlets progressively restricted. It is now the time for individual foundrymen to consider how they can produce high-duty iron and lay definite plans for its production before they wake up to find their market gone. Most customers who want both common and high-duty irons for different purposes will favour that producer who can supply all their casting needs rather than only a part of them.

High-duty iron may be defined as A.S.T.M. Class 40 iron, *i.e.*, that which, in a 1.2-in. arbitration bar, shows 18 tons per sq. in. tensile strength or more, with the "or more" going up to 26 tons and perhaps higher.

Factors of Cost

In the production of high-duty cast iron, as of any other product, the cost is made up of two factors—raw materials and conversion costs. What is wanted is the lowest *total* cost. With prices of raw materials fluctuating as they do, it is advisable to have techniques at hand suited to different types of raw materials, so that a shift may be made at short notice to the combination of material and technique that is most economical.

However, one of the items in conversion costs is interest and amortisation on equipment installed to give this flexibility, but held idle in periods when its use is not economical.

Potential Methods

The foundry desiring to make high-duty grey iron has several recognised choices of doing it, *e.g.*, (1) in the cupola by holding carbon and silicon at the necessary low levels; (2) by alloying additions to a weak iron; (3) by cold melting in or (4) by duplexing to an electric, an air furnace, or some equivalent. Each of these is commercially used.

Technically, the electric melting methods are the most easily controlled and, since they allow use of large proportions of cheap borings and turnings, the economics are very attractive whenever reasonable power rates can be had, and the furnace can be kept busy. However, the first cost of an electric equipment is rather high so that interest charges pile up in idle periods, and this is aggravated by the demand charge for power which makes the conversion cost rise steeply when the electric unit is intermittently operated. Many foundrymen have therefore had to forego the convenience of an electric unit because there is insufficient assurance that it can be kept busy.

On the other hand, attached foundries in large production with an assured output have shown great ingenuity in developing some of the more difficult techniques that can, with enough supervision, be made to give very low conversion cost.

The jobbing foundryman who is just breaking into the high-duty cast iron field is betwixt and between. He is not assured of a steady enough market to justify either buying an electric unit, or of developing the technique and control characteristic of the large attached foundries making non-alloyed high-duty irons. His usual way out of the dilemma is to use his regular soft iron and load it up with alloys till it meets the high-duty specifications. *This is an uneconomical use of alloys.* As has been stated in the A.F.A.-A.S.T.M. Symposium,[3] "Alloys should be added to a good base iron and not used in an attempt to make a poor iron into a fair one."

In theory, at least, the duplexing principle should be applicable to the making of high-duty iron, either for use as it is, or for economical alloying to make still better irons, and without the necessity of expensive equipment. It is this possibility that will be explored to some extent in the following paragraphs.

High-duty iron has already been defined as that of A.S.T.M. Class 40, *i.e.*, that which gives 18 tons tensile in a 1.2-in. bar. Chemically, in unalloyed iron, this means metal of about 3.00 per cent. total carbon, 1.75 per cent. silicon, with the silicon, of course, varied according to section, and with some of the silicon used as an inoculating ladle addition in order to produce "normal" iron, with the proper structure.

It is possible to make stronger unalloyed iron by further reducing the carbon, and this action intensified, associated with a different adjustment of silicon, is made for pearlitic malleable, say 2.75 per cent. carbon; regular malleable, say 2.50 per cent. carbon; and super-strength malleable, say 2 per cent. carbon; and together with suitable alloy additions for the Ford family of alloys at, say, 1.50 per cent. carbon.

Unless some sort of malleablising heat-treatment is to be applied, it is probably not wise to overstep the sensible mean and try to force the base iron to too high a strength. The super-strength unalloyed irons have greater shrinkage, higher melting points, and poorer flowing power. They offer more difficulty in getting sound castings. Since the real problem is production of castings, not test bars, taking the carbon and silicon down to the lowest possible level that will give grey castings is not necessarily the best answer. Morken[4] calls such iron "tricky."

Basic Irons

It is possible to play the upper part of the carbon scale on the cupola, but the further down on the scale the sourer the notes are likely to be. Nevertheless, Judson[5] regularly makes hard iron of 2.40 per cent. carbon, 1.35 per cent. silicon in one cupola for mixing with soft iron from another cupola to produce a final mix of about 2.75 per cent. carbon, 1.60 per cent. silicon for heavy castings. MacPherran[6] regularly produced metal under 3.00 per cent. carbon from the cupola. Smalley[7] also reports such cupola iron. In all these cases, the cupola charge is very high in steel scrap. There is no doubt at all that metal of the 2.80 to 3.10 per cent. carbon range desired for high-duty iron to be cast grey *can* be obtained from the cupola, and cupola malleable is regularly made at this carbon level.

Neither is there any doubt that it is really difficult to make the cupola consistently produce these low carbons and at the same time produce sufficiently hot metal. Since the cupola melts the metal in contact with the coke, carbon is inevitably picked up to some level governed by the metal charge, the coke, and the mode of operation of the cupola. These factors can be more readily controlled to give the combination of hot metal and small fluctuation from the carbon level aimed at, if this level is set at, say, 3.30 per cent. carbon rather than 3 per cent. It might be said that the average cupola under average operation is more "contented" when it "gives down" 3.30 per cent. carbon.

Cupola and Low Cost

The silicon level must be held low enough so that the final "inoculating" addition can be made. The minimum addition is generally around 0.25 per cent. Hence, the problem may be phrased as the production of molten iron of 3.00 per cent. carbon and 1.50 per cent. or less silicon, at a high enough temperature level to take up the addition and allow plenty of time for pouring. The desire is to do as much as possible in the cupola because that is the cheapest melting method considering both first cost of equipment and fuel consumption. Hence, a still more precise phrasing of the problem is: the adjustment of cupola metal to the desired carbon and silicon level. By using a charge high in steel, the silicon can be kept low and the desired silicon added at a later stage, in which case the problem is merely one of lowering carbon from 3.30 to 3 per cent. This can be done either by oxidation of one-tenth of the carbon, or by about 10 per cent. dilution with molten low carbon steel.

If the desire is to divert a part of the regular soft iron of, say, 3.40 per cent. carbon, 2.20 per cent. silicon for use as a base for alteration to the high-duty composition, a large dilution would be required to bring the silicon where it is wanted, so it will be sensible to oxidise part of the silicon before dilution.

Oxidising Cast Iron

These paragraphs have contained some glib talk about oxidising carbon or silicon in these two cases, as if such oxidation would not adversely affect quality, a matter that requires proof.

Yet the mere fact that the raw material has at some time been subjected to strongly oxidising conditions need not mean that the final product is any the worse. Actually, all iron starts out as iron oxide in ore, and all steel made with blast-furnace metal in the charge must be severely oxidised to burn out the carbon in the pig-iron. Foundrymen know that converter steel is cupola metal oxidised in most drastic fashion before final deoxidation, yet well-made converter cast steel is very good material. Indeed, a vigorous boil is good medicine for most cast ferrous products. There is as much reason to expect benefit as harm from an oxidising step in production.

At any rate, when the melt is made to the chemical composition desired, the first step has been taken toward putting it in proper shape for casting. Given the desired chemistry, the metallurgist can usually find out how to put on the finishing touches.

In large-scale operation, the composition of cupola metal is satisfactorily adjusted through an oxidising step. Malleable[8] has been made by blowing part of a cupola charge and mixing the blown metal with unblown metal and slightly superheating in an electric. The Ford 1.50 per cent. carbon metal for brake drums is so made at Campbell, Wyant & Cannon.

It is not necessary to use a converter, as the same reaction can be brought about with solid iron oxide. Kinnear,[9] following earlier published suggestions of Hall,[10] and unpublished sug-

* Extracted from a Paper presented to the Chicago regional conference of the American Foundrymen's Association.

gestions of Melmoth and Batty, duplexed cupola melts from all-steel charge down to cast steel composition by oreing down in the basic electric. He saved half the electric energy required for a cold melt, doubled the furnace output and made good grade B steel. Such steel practice calls for desulphurising the cupola metal, but that is not difficult nowadays.

To check the feasibility of lowering the carbon from the composition which a cupola will readily "give down" from an all-steel charge, a 300-lb. melt of 3.34 carbon, 0.21 silicon, 0.22 manganese, 0.05 phosphorus, 0.10 per cent. sulphur was made in a basic-lined induction furnace. With the metal at 1,540 deg. C., 6.85 lbs. of mill scale was added over a period of 26 min. When the boiling stopped, a sample analysed 3.04 carbon, 0.04 silicon, 0.07 per cent. manganese. Additions of ferro-silicon, calculated for 1.75 per cent. silicon, and ferro-manganese, calculated for 0.50 per cent. manganese, were made. A sample taken after the additions had become diffused showed 2.98 carbon, 1.79 silicon, 0.63 manganese, 0.042 phosphorus, 0.084 per cent. sulphur. One ladle was poured from the furnace at once, another after holding 5 min. and a third after 10 min., because, from the work of Crosby and Herzig[11] and other similar data, there was fear that the addition of all the silicon to the ladle would not be effective. In all cases, the metal was poured at 1,425 deg. C. into $\frac{7}{8}$-in., 1.2- and 2-in. test bars. The mechanical properties are shown in Fig. 1. All the bars were sound. The only difference from other irons of similar structure and composition was that the fracture was a bit more shiny and more nearly black instead of the usual grey, which is probably ascribable to the nice arrangement of the graphite flakes. With all 1.2-in. bars running between 19.4 and 21.0 tons per sq. in. tensile and the 2-in. bars between 16.2 and 18.7, as shown in Fig. 1, and with the microstructure, it was clear that this heat is the desired Class 40 high-duty iron. The silicon addition behaved satisfactorily, giving ample time for pouring. Thus, reduction of carbon by solid iron oxide has possibilities.

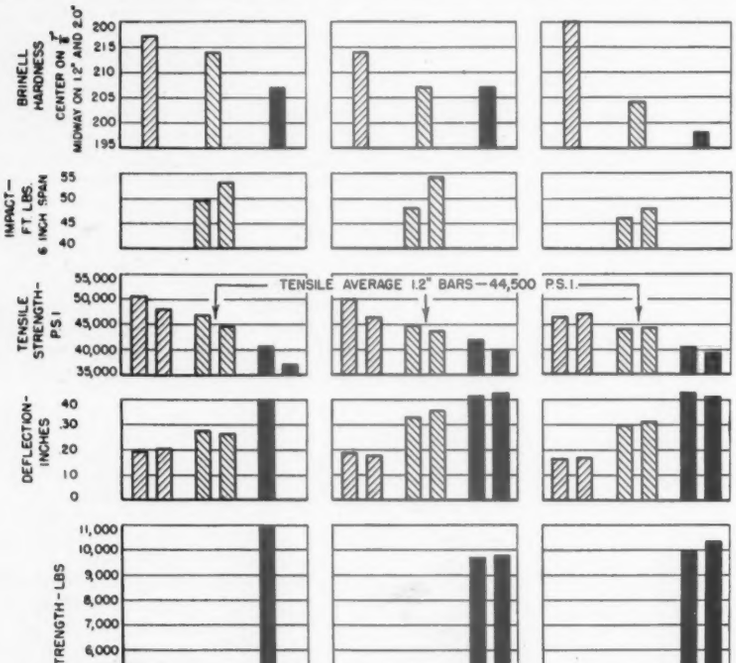

FIG. 1.—MECHANICAL PROPERTIES OF TEST-BARS.

TABLE I.—*Mechanical Properties of Iron Containing T.C. 2.96, 1.73 Si, 0.55 Mn, 0.18 P, 0.03 S, Obtained by Soda Ash, Mill Scale and Fer-X Treatment of an Initial 3.35 C, 2.30 Si, 0.70 Mn, 0.18 P, 0.10 S Iron, with Final Addition of 0.25 per Cent. Si.*

Poured from ladle.	Size of bar. In.	Transverse test, corrected breaking load. Lbs.	Corrected deflection. In.	Tensile strength. Tons per sq. in.	Brinell hardness. Centre.	Brinell hardness. Midway between centre and outside.
1	$\frac{7}{8}$	1,600	0.160	22.80 22.86	241	
1	1.2	2,880 2,970	0.228 0.260	21.04 21.07	223 223	
1	2.0	10,550	0.301	17.77 19.25	207	217
2	1.2	2,620 2,660	0.193 0.210	20.31 20.50	232 232	

Note.—Ladle 1 was poured 3 min. after the silicon addition; ladle 2 after a further 10 min.

Preferential Oxidation

It is fundamental in the oxidation of pig-iron to steel or to some intermediate carbon content, that at the temperature of cupola metal, the silicon and manganese have to be removed quite completely before the carbon is attacked. That is, the more readily oxidisable silicon and manganese protect the carbon.

Handling, in this way, an initially soft iron, higher in both carbon and silicon than is desired, so as first to remove most of the silicon and then the desired amount of carbon, is therefore not feasible. Oxidation of silicon only, followed by dilution of the melt with molten steel may, however, be resorted to. Initial adjustment of the charge to give the desired silicon, followed by duplexing in the electric where a 10 per cent. steel addition is made for dilution, has been described for malleable and high-strength iron by Morrison,[12] by Bremer[13] and by Moore.[14] Their requirements for added heat beyond that of the incoming cupola charge range from 55 to 110 kw.-hr. per ton, so something of this order must be added in non-electric practice.

At first sight this seems a tough nut to crack. However, there is a way to crack it. The reader is probably familiar with thermit welding, and thermit steel could conceivably be used. Actually, aluminium is rather expensive fuel, and an excess of aluminium carried into the iron might not be healthy for it. Udy, of the Chromium Mining & Smelting Corporation, has proposed the use of silicon thermit, since an excess of silicon left over from the reaction is compatible with cast iron, and such an addition can be allowed for. This material is being studied at Battelle. Instead of using iron oxide and aluminium as the heat-generating agents, as is done in alumino-thermics, sodium nitrate and ferro-silicon are used. Just as in the converter, silicon is oxidised before the iron, forming silica which is fluxed by the sodium oxide from the nitrate. If desired some lime may be added as a further flux. The reaction generates enough heat to melt cast iron chips or steel clippings almost instantaneously. The iron of the ferro-silicon plus that in the chips or clippings is thus supplied molten and at a high temperature. The mixture of nitrate, ferro-silicon and metal to be melted is termed "Fer X."

Fer X as Temperature Addition

This method can be seen to be a sensible one if the heat of oxidation of silicon is recalled. About 0.08 lb. of silicon is required to produce 1 lb. hot molten steel. The heat of combustion of that amount of silicon is equivalent to about 0.215 kw.-hr. Therefore, if 200 lbs. of iron is added from Fer X to 1,800 lbs. molten cast iron, in the process heat is generated equivalent to 43 kw.-hrs., but since the heat is generated in place and almost instantaneously, the efficiency will be higher than that of the utilisation of an equal number of kw.-hr. in the electric furnace, and the Fer X addition should be as effective as the use of 75 kw.-hrs. in an electric furnace. If the Fer X is added in a heated forehearth, its action should be approximately equivalent to that of the usual electric duplexing method of dilution with cold steel.

Until the chemists solved the problem of nitrogen fixation so that the price of sodium nitrate came down, it would have been uneconomic to attempt to exploit this reaction.

Under present conditions it affords a means of making what might be termed "a ladle addition of temperature," if the melt it produces is calculated for the same composition as the melt to which it is added, or simultaneously, of temperature and a low carbon melt for dilution. The silicon of the dilution addition can be kept low, or the desired final addition of silicon can be made simultaneously in the molten state by adjusting the Fer X composition to have excess silicon. A trial of this method gave the following results:

A 100-lb. heat consisting of three-fourths briquetted borings, one-fourth heavy scrap was melted down in the basic induction furnace to a calculated composition of 3.35 per cent. carbon, 2.30 silicon, 0.70 manganese, 0.10 sulphur, and 0.18 phosphorus. It was treated with 1 lb. soda ash and the slag removed. Mill scale was then added, calculated to reduce silicon to 1.65 per cent. slag removed. Fer X was then added for dilution of carbon and silicon to 3 per cent. carbon, 1.50 silicon, and a final inoculating addition of 0.25 per cent. silicon as ferro was made. After holding 3 min., a set of ¼-, 1.2- and 2-in. test bars was poured, and after 10 min. more another set of 1.2-in. bars was poured. The metal was kept at 1,565 to 1,455 deg. C. during the half hour used in applying the various treatments by the application of power as needed. Both ladles were poured at 1,400 deg. C.

The finished iron analysed 2.96 per cent. carbon, 1.73 silicon, 0.55 manganese, 0.03 sulphur and 0.18 phosphorus. The properties are shown in Table I.

The microstructure of the metal from the first ladle was normal. That from the second showed a trace of a tendency toward modification, but the mechanical properties show the second ladle still to be high-duty iron, so that pouring time should be ample.

The four 1.2-in. bars from this heat ran between the close limits of 20.3 and 21.06 tons per sq. in. tensile, averaging about 20.75 tons. The requirement of 17.85 tons per sq. in. has been exceeded, starting with a soft iron melt that was three-fourths briquetted borings. The test does not prove that cupola metal and a heated forehearth would be as easy to handle, but it does indicate that the chemistry of the process does work. A suitable heated forehearth would have to be designed. It will also be necessary to work out chill tests or other rapid tests by which the composition can be checked at various stages in the process, until the procedure has become routine. In a first attempt the oreing down and dilution were overdone, and the result was a metal of 2.44 carbon, 1.56 silicon, which was white in the second ladle poured. Correcting the aim by the experience on the first shot, the bird was hit with the second barrel.

(To be continued.)

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A New Foundry Residues Recovery Plant

Throughout the ages, metalliferous mining has depended upon differences in specific gravity for the extraction of metal from ore and the concentrating table has long been an important adjunct in treatment plants for the recovery of metal by gravity concentration. For many years, the non-ferrous foundry industry has realised the high metal content of the waste sands and slags and as metal can first be recovered from the earth, so may it be reclaimed from the discards of industry.

The accumulated material is often a mixture of sand, graphite, cores, clinker, dross, spillings and swarf, the whole of which must be ground so as to free the metal, whether in large or small particles, from the foreign matter which has been attached to it—often in the form of adhesions—during processing.

It sometimes happens that large lumps are present, and where this occurs, they are reduced in a jaw-crusher, the product discharging into a feeder which regulates the quantity entering the main plant. Either a belt and bucket elevator or, if there be sufficient space, a belt conveyor elevates the crushed material to a ball mill. Using suitable grinding media, the metal is released, and the larger pieces will remain in the mill body until the mill receives its periodical cleansing. Such metal is so thoroughly cleansed that it is quite suitable for remelting.

FIG. 1.—CLOSE-UP OF CONCENTRATING TABLE DEALING WITH FOUNDRY RESIDUES.

FIG. 2.—A MODERN METAL-RECOVERY PLANT INSTALLED IN THE SHOPS OF SHIPHAM & COMPANY, LIMITED, OF HULL.

On the discharge end of the ball mill is fitted a revolving trommel screen through which the ground mixture of sand, slag and metal passes. The throughput is now in such a form, *i.e.*, ground, washed and sized, that it is ready for separation by gravity. The concentrating table having its feed box directly under the trommel screen of the mill completes the process of separation by delivering metal as a concentrate which is collected by means of a dividing launder at the discharge end of the table deck.

The waste sands, etc., having a lower specific gravity than the metal, flow over the riffles to the tailings launder and thence to dump. At the end of a day's run, the oversize from the trommel screen is separately concentrated by the table as previously described.

The disposal of the waste sand and the economy of water are two factors which have very often to be considered, but can be effected by the installation of a simple drag de-waterer and the provision of settling pits.

The tailings launder may be so arranged that it leads into the boot of the de-waterer which will deliver a sand in a sufficiently dry state

(Continued on page 108.)

Founders' Forum

MOULDS FOR COPPER ALLOYS

Q.—Difficulties have occurred in producing various types of cast-iron moulds for casting non-ferrous alloys such as 70/30 brass, bronze, etc. The castings consist chiefly of "strip" moulds with lid and back faces machined, and failure takes the form of premature cracking and "crazing." The same problem occurs with billet, wire-bar and cannon moulds for casting copper alloys. What is a suitable composition for these castings?

A.—Where strip moulds for casting copper alloys have to be machined on the faces which are in contact with the molten metal (and this is almost invariably the case in modern plant), it is necessary to use a cast-iron composition which will yield close-grained surfaces after machining and yet possess sufficient strength and pliability to withstand thermal shocks.

The process of casting and resetting the moulds leads to an intermittent "breathing" action which deforms the moulds first one way and then the other. Consequently the moulds must be made from a heat-resisting type of cast iron which will take kindly to this repeated deflection and reversal.

Several types of cast iron are used with success, the selection depending on the conditions of service called for. When the output is likely to be small or moderate and consequently low initial cost is important, and the finish of the billet or slab is not required to be of the highest order, a low-silicon hematite type of composition is usually adopted. A suitable specification would be as follows:—Total carbon, 3.4 to 3.6; silicon, 1.2 to 1.6 (depending on the sectional thickness of the castings); manganese, 0.6 to 0.9; sulphur, 0.10 (max.); and phosphorus, 0.25 (max.) per cent. The total-carbon content of this mixture tends to give some degree of pliability, but, particularly in strip moulds of heavy section, it is difficult—in fact, almost impossible—to avoid openness of grain after machining with this composition. In order to meet this difficulty, castings of this type are often specified in Lanz Perlit Iron. By using the hot-mould process, the silicon content can be greatly reduced. Also, the slow rate of cooling associated with this process produces a type of cast iron with a high degree of shock resistance and with a high deflection value; yet it gives a very fine finish after machining. The grade of Lanz Perlit iron to be used should contain 3.3 to 3.5 per cent. total carbon with silicon as low as possible.

Where long runs of standard-type billets have to be produced to a very high quality finish, low nickel-chromium cast irons of balanced composition have been used with considerable success. A high total carbon content is again essential, the heat-resisting qualities being obtained from the carbide-stabilising properties associated with chromium additions, while such properties as strength, uniformity and density of structure and a good deflection value, coupled with good machinability and high quality of finish, are achieved by the nickel content.

A typical composition would be as follows:—Total carbon, 3.4 to 3.6; silicon, 1.2 to 1.6 (depending on the sectional thickness of the castings); manganese, 0.6 to 0.9; sulphur, 0.12 (max.); phosphorus, 0.20 (max.); nickel, 1.5 to 1.8; and chromium, 0.4 to 0.6 per cent.

For billet and wire-bar moulds which are normally constructed in halves, the above types of cast iron are also successfully used. Where the sectional thicknesses are considerably in excess of those encountered in strip moulds, in each case the silicon should be reduced to the lowest level consistent with machinability.

In connection with castings for this service, it cannot be too strongly stressed that complete soundness of structure throughout the whole casting is absolutely essential for success. It is useless to employ a suitable composition, either plain or alloyed, if the castings are unsound. A particularly frequent defect in strip moulds is the presence of liquid shrinkage defects (commonly described as "draws") in some part of the castings, usually beneath the working surface, which are not revealed during the machining operation. The defects are usually only revealed when the castings have been broken up as scrap, following premature failure due to crazing or horizontal cracking.

For "cannon"-type billet moulds which are not split and consist essentially of very heavy walled tubes, with machined bore, the nickel-chromium type of cast iron mentioned above has proved particularly useful. In this type of mould it is extremely important that the castings should be sound throughout. This is most readily guaranteed by placing a taper-shaped feeding head of adequate bulk on the top end of the casting (such castings are always cast vertically), similar to the practice adopted for heavy-section diesel cylinder liners. The feeding head is parted off prior to the boring and facing of the casting.

"Rod" or "puddle" feeding should on no account be tolerated in work of this kind.

Q.—Which sands should be used for bronzes?

A.—In order to obtain the best results, care should be taken in regard to the sand employed. Properties found suitable using a sand of the Bunter group, such as Mansfield or Belfast, will be as follow:—Green compression strength (A.F.A.), 4.0 to 5.0 lbs. per sq. in.; permeability A.F.A. No., 20 to 30; and moisture, 5 to 7 per cent.

District Presidents

No. 5—BRISTOL

MR. MYERS WAYMAN, President of the Bristol Section of the Institute of British Foundrymen, was apprenticed to the foundry trade at the North Eastern Marine Engineering Company, Limited, of Sunderland. Then leaving the Wear for the Tyne, he passed ten years in the well-known foundry of Palmers, of Jarrow, which at that time was undertaking vast quantities of Admiralty work. Further experience having been gained on turbine castings at the works of Charles W. Taylor & Company, Limited, of South Shields, Mr. Wayman was appointed foreman at G. K. Stothert & Company, of the Hotwells Dry Dock, Bristol. This started a 30-year association with that city, the last twelve of which he has spent as foreman to J. Jefferies & Sons, Limited, at their Hotwells Foundry. This firm are the owners of the Wapping Dry Dock and also have large ship-repairing shops at Avonmouth.

MR. M. WAYMAN.

(*Continued from next column.*)

cases repairs can be made without dissembling the part.

Three qualities of aluminium solder with melting points ranging from 250 to 350 deg. C. are available.

Use of Aluminium Solder

"Tandem News," the house organ of the Eyre Smelting Company, Limited, of Merton Abbey, London, S.W.19, gives the following hints on the process of soldering by the use of aluminium.

(1) Cleanliness is essential. Clean the surface to be joined; use clean tools. Flux is not necessary.

(2) Heat a radius of 6 to 9 in. round the spot to be soldered to allow for expansion and contraction of the new metal to be added.

(3) Rub the solder stick on the aluminium until it melts.

The following point is very important:—

(4) Immediately the solder is fluid, scrape the surface of the aluminium which is beneath the solder so as to provide a perfectly clean surface which is essential to make a good job. This is necessary because a skin forms on the aluminium during heating and must be removed to obtain perfect bonding. This is the important part of the operation. A sharp tool is necessary (such as the end of a broken hacksaw blade, a screwdriver, or an ordinary nail flattened with a hammer) and it should be used vigorously. The molten aluminium solder should be scraped and rubbed hard into the surface of the aluminium itself.

(5) If joining two parts, both surfaces should be well tinned before completing the joint.

(6) Skim off the oxide which forms on the surface of the solder and complete the joint. The solder will remain pasty for some minutes; sufficient time should be allowed for it to solidify before the joint is subjected to strain or pressure.

(7) Cold draughts should be excluded and the work cooled as slowly as possible.

Butt Joints

Chamfer the two edges the whole depth of the material and warm sufficiently to melt solder. Test by rubbing a stick against the surface. Quickly scratch away all oxide, oil, etc., from adjacent surfaces with an old file or wire brush and, simultaneously, rub on the solder, building it up to required thickness. Withdraw heat, shape and smooth off with a steel spatula (a thin hacksaw blade makes a good tool).

Repairing Cracks

File or chip out the defect the whole depth of the material, and then proceed as for butt joints. Remember that a notched plate or bar is comparatively very weak and so joints must be made wide enough to let the solder go right through. A skin of solder only binds the cracks—it does not repair them.

Filling Holes

It often happens that what appears to be a small hole on the surface may be quite a large fault. Care should be taken to drill a sufficiently large hole to encircle the fault entirely. After drilling, heat as described, clean edges thoroughly (and the inside of the hole if possible), and then pour in molten solder and finish off.

Stripped Threads, Stud Holes, etc.

When threads have stripped, or studs and the like pulled out, the hole should be drilled larger, the stud or bolt placed and fixed centrally in position, and, after heating the job carefully, the solder should be poured in and the repair finished off. The usual precautions as regards cleanliness should be taken.

Some of the advantages of using aluminium solder are:—(1) It is suitable for aluminium and its alloys; (2) it makes a good colour-match; (3) no distortion of the aluminium, since the working temperature is fairly low; (4) in most

(*Continued in previous column.*)

Effect of Aluminium and Antimony on Cast Red Brass

By H. B. GARDNER and C. M. SAEGER, Jun.

(*Continued from page* 80.)

Density

Density was determined on the ends of the broken tension test specimens by the conventional method of displacement of water. Data values are at 20 deg. C. The data on the influence of added aluminium are summarised in Fig. 7 and for antimony in Fig. 8. In Fig. 7 it is shown that the general trend is for a lowering in density, which can be attributed to the aluminium present. The no-side-chill bars cast at 1,065 deg. C. and 1,150 deg. C. are the only ones, however, where this decrease was uniform. In Fig. 8 the deviation from remelted alloy, due to the addition of antimony, was nominal for the bars cut from the chill ingot. The sand-cast bars poured at 1,230 deg. C. showed the most pronounced irregular deviation.

Additional determinations of density were made on stepped-bar castings poured from each heat that was cast into tensile bars. Fig. 9 shows the dimensions of the stepped-bar castings. In Figs. 10 and 11 are shown the density data obtained with this type of bar for alloys with added aluminium and antimony respectively. The general effect of increasing the aluminium content was to decrease the density. The density also tended to decrease with reduction of the thickness of the stepped-bar casting although this reduction is somewhat irregular. There are some indications, too, of a decrease in density with an increase in pouring temperature, particularly for the specimens with 0.05 and 0.10 per cent. aluminium. In general the addition of antimony had very little effect on the density of the stepped-bar specimens. There were fewer irregularities in the density determinations of the stepped-bars containing antimony than for the corresponding bars containing aluminium. There was a slight tendency for the density to decrease with reduction in thickness of casting of specimens poured at 1,065 deg. C. and 1,150 deg. C., but this was not so evident with specimens cast at 1,230 deg. C.

Running Qualities

The effect of aluminium and of antimony on the running quality of the alloy was studied by Saeger and Krynitsky,[6] which consisted essentially in casting in a green sand mould a strip of small cross-section in the form of a spiral. According to data summarised in Fig. 12 aluminium increased the running quality of the alloy. Likewise the results presented in Fig. 13 show a marked increase in the running quality of the alloy which can be attributed to the presence of antimony. In the specimens poured at temperatures of 1,065 deg. C. and 1,150 deg. C., maximum values were obtained with an antimony content of 0.15 per cent., but for the test specimens poured at 1,230 deg. C. the

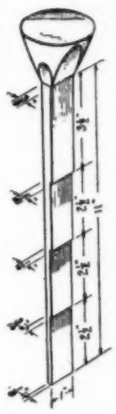


FIG. 9.—DIMENSIONS OF STEPPED-BAR CASTINGS.

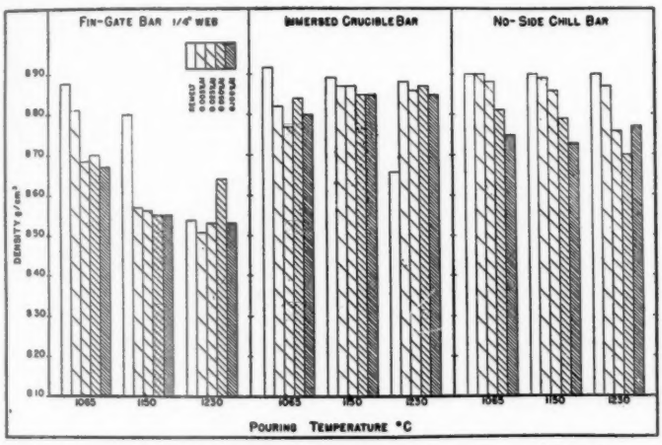


FIG. 7.—EFFECT OF ALUMINIUM ADDITIONS ON DENSITY OF CAST RED BRASS.

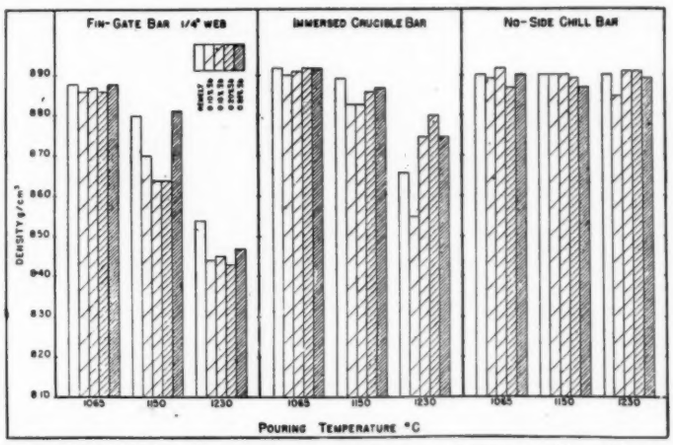


FIG. 8.—EFFECT OF ANTIMONY ADDITIONS ON DENSITY OF CAST RED BRASS.

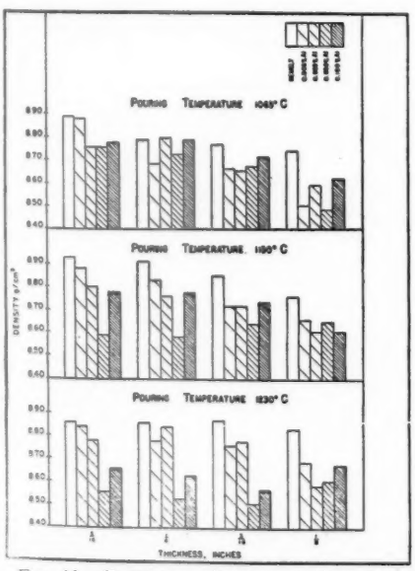


FIG. 10.—EFFECT OF ALUMINIUM ADDITIONS ON DENSITY OF STEPPED-BAR CASTINGS OF CAST RED BRASS.

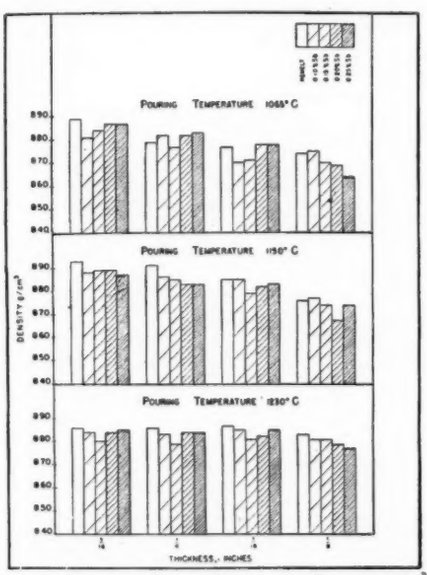


FIG. 11.—EFFECT OF ANTIMONY ADDITIONS ON DENSITY OF STEPPED-BAR CASTINGS OF CAST RED BRASS (85-5-5-5).

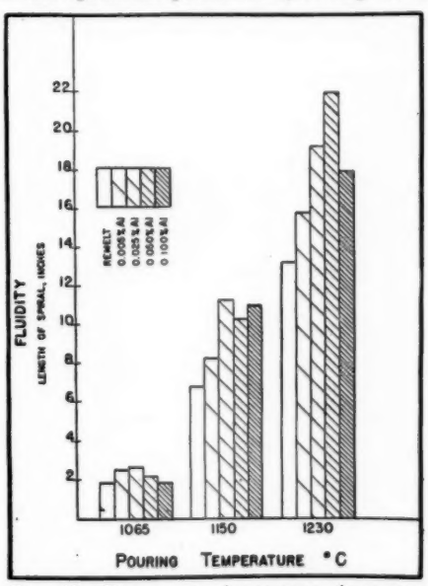


FIG. 12.—EFFECT OF ALUMINIUM ADDITIONS ON FLUIDITY OF CAST RED BRASS (85-5-5-5).

best results corresponded to an antimony content of 0.10 per cent.

Pressure Testing

Since this alloy is widely used in the manufacture of pressure castings, its tightness is a major factor. This was studied by hydraulic testing. A hydraulic pressure of 300 lb. per sq. in. was applied to the interior of cylindrical castings. The water within the specimen contained a soluble blue dye and the appearance of the blue colouration on the outer surface of the specimen under pressure constituted visual evidence of a leak. If no leak was indicated when the pressure had been maintained for 1 min., the specimen was rated "satisfactory" or "O.K."

Cylindrical specimens for these pressure tests were cast in groups of four as indicated in Fig. 14. Two of the thin-wall castings in each group were trimmed to a length of 2 in., removing most of the material from the gate-end, which might possibly be spongy. These specimens were tested hydraulically with the inner and outer surfaces in the "as cast" condition. The other two cylinders in each group, likewise trimmed to a length of 2 in., were machined both inside and out to a wall-thickness of $\frac{1}{4}$ in. and tested in a similar manner. Specimens in both the "cast-to-size" and "machined-to-size" conditions were tested under a hydraulic pressure of 300 lb. per sq. in. Specimens which did not leak under 300 lb. per sq. in. pressure were subsequently tested under a pressure of 600 lb. per sq. in. Results of these pressure tests are listed in Tables I and II. These data show:—

(1) The "cast-to-size" specimens were superior to the "machined-to-size" specimens in resistance to hydraulic pressure. This indicates that an important part of the resistance to hydraulic pressure is located in the skin of the casting and that the removal of the surface skin by machining decreases the capacity of the metal to withstand hydraulic pressure.

(2) The best results were obtained with metal cast at the higher pouring temperatures.

(3) The presence of aluminium in the alloy increased the tendency for leaks or porosity, particularly when 0.05 per cent. of this element or more was present.

TABLE I.—*Pressure Tests of Remelted "85-5-5-5" Alloy with Addition of Aluminium.*

Pouring temperature. Deg. C.	Type of metal.	Cast-to-size.		Machined-to-size.	
		300 lb.	600 lb.*	300 lb.	600 lb.*
1,065	Remelt	NG	—	NG	—
		OK	OK	NG	—
1,150	Remelt	OK	OK	OK	NG
		OK	NG	OK	NG
1,230	Remelt	OK	OK	OK	OK
		OK	OK	NG	—
1,065	Remelt plus 0.005 per cent. Al.	misrun	—	NG	—
		—	—	NG	—
1,150	Remelt plus 0.005 per cent. Al.	OK	OK	OK	NG
		NG	—	NG	—
1,230	Remelt plus 0.005 per cent. Al.	OK	OK	OK	OK
		OK	OK	OK	OK
1,065	Remelt plus 0.025 per cent. Al.	NG	—	NG	—
		OK	OK	NG	—
1,150	Remelt plus 0.025 per cent. Al.	OK	OK	NG	—
		OK	OK	NG	—
1,230	Remelt plus 0.025 per cent. Al.	OK	OK	OK	NG
		OK	OK	OK	NG
1,065	Remelt plus 0.05 per cent. Al	NG	—	NG	—
		NG	—	NG	—
1,150	Remelt plus 0.05 per cent. Al	NG	—	NG	—
		NG	—	NG	—
1,230	Remelt plus 0.05 per cent. Al	NG	—	NG	—
		OK	OK	NG	—
1,065	Remelt plus 0.10 per cent. Al	NG	—	NG	—
		NG	—	NG	—
1,150	Remelt plus 0.10 per cent. Al	NG	—	NG	—
		OK	OK	NG	—
1,230	Remelt plus 0.10 per cent. Al	NG	—	NG	—
		NG	—	NG	—

* Only those specimens that withstood a pressure of 300 lbs. per sq. in. were tested at 600 lbs. pressure.

TABLE II.—*Pressure Tests of Remelted "85-5-5-5" Alloy with Additions of Antimony.*

Pouring temperature. Deg. C.	Type of metal.	Cast-to-size.		Machined-to-size.	
		300 lb.	600 lb.*	300 lb.	600 lb.*
1,065	Remelt	NG	—	NG	—
		OK	OK	NG	—
1,150	Remelt	OK	OK	OK	NG
		OK	NG	OK	NG
1,230	Remelt	OK	OK	OK	OK
		OK	OK	NG	—
1,065	Remelt plus 0.10 per cent. Sb	OK	OK	OK	NG
		OK	OK	OK	NG
1,150	Remelt plus 0.10 per cent. Sb	OK	NG	OK	NG
		OK	OK	NG	—
1,230	Remelt plus 0.10 per cent. Sb	OK	OK	OK	OK
		OK	OK	OK	OK
1,065	Remelt plus 0.15 per cent. Sb	OK	NG	NG	—
		OK	OK	NG	—
1,150	Remelt plus 0.15 per cent. Sb	OK	OK	OK	NG
		OK	OK	OK	NG
1,230	Remelt plus 0.15 per cent. Sb	OK	OK	OK	OK
		OK	NG	OK	OK
1,065	Remelt plus 0.20 per cent. Sb	OK	NG	NG	—
		misrun	—	OK	NG
1,150	Remelt plus 0.20 per cent. Sb	OK	OK	NG	—
		OK	OK	OK	OK
1,230	Remelt plus 0.20 per cent. Sb	OK	OK	OK	OK
		OK	OK	OK	OK
1,065	Remelt plus 0.25 per cent. Sb	OK	NG	NG	—
		misrun	—	NG	—
1,150	Remelt plus 0.25 per cent. Sb	OK	OK	OK	NG
		OK	OK	OK	NG
1,230	Remelt plus 0.25 per cent. Sb	OK	OK	OK	OK
		OK	OK	OK	OK

Only those specimens that withstood a pressure of 300 lbs. per sq. in. were tested at 600 lbs. pressure.

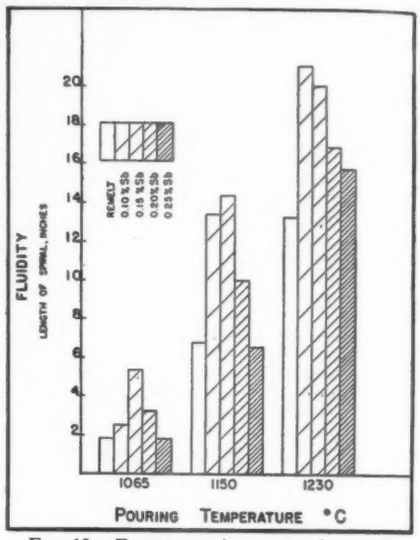


FIG. 13.—EFFECT OF ANTIMONY ADDITIONS ON FLUIDITY OF CAST RED BRASS (85-5-5-5).

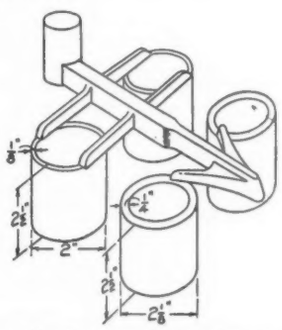


FIG. 14.—CASTING OF SPECIMENS FOR HYDRAULIC TESTS.

(4) The presence of antimony decreased the porosity of red brass but the effect was practically constant within the range of 0.10 to 0.25 per cent. antimony.

(5) For the test specimens containing aluminium, all of the "cast-to-size" specimens that withstood 300 lb. per sq. in. pressure were also able to withstand 600 lb. per sq. in. pressure. Only two of the six "machined-to-size" specimens that withstood 300 lb. per sq. in. pressure passed the 600 lb. per sq. in. test.

(6) Most of the "cast-to-size" specimens containing antimony that withstood 300 lb. per sq. in. pressure were satisfactory under 600 lb. per sq. in. pressure, and one-half of the "machined-to-size" specimens tested in like manner were satisfactory.

In general, then, it may be seen that aluminium has a deleterious effect on the pressure tightness of the alloy but that antimony does not deleteriously affect this property. It was interesting to note that the leaks observed in the specimens that failed under test were not localised but were distributed generally.

6 Saeger, C. M., Jun., and Krynitsky, A. I. "A Practical Method for Studying the Running Quality of a Metal Cast in Foundry Moulds." Trans., A.F.A., Vol. 39, p. 513 (1931).

Gating and Pouring Temperatures in Non-Ferrous Foundry Practice*

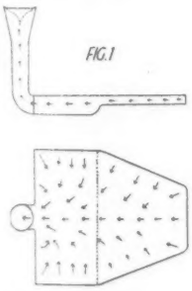
By J. LAING (Oldham)

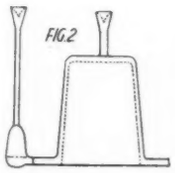
The executive of a foundry producing both ferrous and non-ferrous castings can count himself fortunate if he has at his disposal skilled ironmoulders with sufficient knowledge of brass-foundry practice to enable them to be transferred to the non-ferrous foundry as the occasion arises. The greatest factor which operates against the successful transfer, and one which also largely operates against the success of an ironfoundry foreman when set to make non-ferrous castings, is the lack of knowledge of the fundamental principles of gating, coupled with inexperience of the effects of pouring temperatures.

In bringing forward this subject, the writer hopes that he will stimulate the interest of the practical man, in other branches of the industry to that in which he is directly engaged, which in turn will do something to remedy the lack of versatility which does exist.

GUN METALS

These alloys enter the tin-bronze group, the best known of which is Admiralty gun metal containing 88 per cent. Cu, 10 per cent. Sn, and 2 per cent. Zn with small amounts of other elements. Although the compositions of gun metals vary widely, there being literally scores of different mixtures in use, the successful methods of gating a particular design in castings can be applied to almost all the alloys that are listed under this heading.





Broadly speaking, the points to bear in mind are so to design the gates as to allow the mould to fill rapidly with reasonable freedom from turbulence and at the same time maintain progressive solidification to the gates, from those points most remote from them.

The general rule with cast iron is to place the ingate or gates, as the case may be, so as to feed directly into the thinner or less massive parts and thereby level up, to some extent, the solidifying of the metal in the mould. In effect, the method acts in a twofold manner: hot metal flowing through the thin parts superheats the mould and, in consequence, arrives in the massive sections in a cooler condition, resulting thereby, to some extent, in a levelling-up of the solidifying range of the metal inside the mould.

With the gun metals, very little use can be made of this practice, mainly because, however well the gates are distributed, complete levelling up of the solidification is seldom, if ever, accomplished. The best successes are therefore achieved by reversing the procedure and feeding the hot metal directly into the massive sections as shown in Fig. 1. By this means, there results a super-heating of the mould walls, which action is progressively diminishing in severity from the gate to the parts of the casting most remote from it.

Another very important point, which is the reverse of cast iron practice, is that it is essential, when dealing with gun metals, to place the vertical gate very close to the casting in order to reduce surface heat conductivity and ensure adequate feedings from the head. The theoretical line of solidification is illustrated by the arrows in Fig. 1. Runner cups or bushes are also differently constructed on small and medium work, and are made to form a funnel leading directly into the gate.

Although it is essential to use large runner gates, for commercial reasons they must not be unnecessarily large, as, besides increasing the melting costs (fuel and labour), they increase melting losses and, what is more important on high-class work, cause an unnecessary large percentage of gate scrap, with the consequent reduction in the value of the metal.

In Fig. 2 is illustrated diagrammatically a choke type of runner by which a considerable weight of metal can be saved while adequate feeding is maintained. Simply explained, it consists of a feeding knob, sufficiently massive to feed the casting, very similar, although larger, to the feeding knobs used in malleable iron practice. The desired shape can readily be formed by means of a suitable wood pattern, preferably split on the dotted line, the two parts being held in position by a centre dowel. When the pattern had been withdrawn, a comparatively small tube is pushed through the cope to form a downgate.

By following the method described, much cleaner casting conditions are obtained because the downgate can be more easily kept choked during the pouring operation. The method can also be applied to small castings moulded in batches either by hand or machine, and Fig. 3 shows the method of application.

Top Gating

Whilst top gating can be used successfully on small castings or even on comparatively large, thin castings, it is not recommended for medium and large work. When soundness or density of the metal is important, the pouring temperature has to be lower than will allow entrained air-bubbles to escape, with the result that air, or blow holes, are revealed on machining.

Risers

Although very great use is made of the runner gate for feeding purposes in the non-ferrous foundry, there are many types of castings that have to be fed by means of risers. A common practice in the iron foundry is to use the top riser almost exclusively when its sole function is the providing of an adequate supply of feed metal. On the other hand, the brass foundry can generally obtain greater soundness by means of side risers, and Fig. 4 illustrates the application of a side riser to a heavy bush casting.

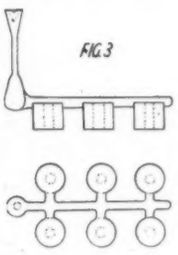
Although side risers of this type adequately provide for solidification shrinkage when correctly proportioned, should they be applied to important work designed to withstand hydraulic pressures, the pouring temperature must be carefully controlled, or a speckled, open grain will develop under the riser. This is caused by the massive riser prolonging the solidification unduly at that point and allowing the dissolved gases to fall out of solution. If, for any reason, the top feeder must be applied, it should be designed so as to ensure the prior solidification of the casting. It is also very essential that generous fillets be used at the junction of all gates, but they must not be made so large as to increase the mass at the point where the casting and gate connect, until it is in excess of the gate above.

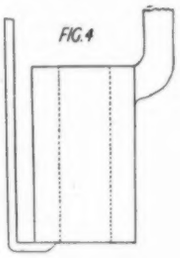
Pouring Temperatures

The correct pouring temperature varies with the mass of the casting and the composition of the mixture. Very small, thin castings in Admiralty gun metal may be satisfactorily poured as high as 1,280 or 1,300 deg. C. For heavy castings, 1,150 deg. C. will be sufficiently high. Very good mechanical tests are obtained when the test-bar is near the gate and, provided the other conditions are correct, by using a pouring temperature of 1,200 deg. C.

For gun metals containing larger percentages of the low-melting-point additions, tin, zinc, or lead, the pouring temperature naturally decreases. The metal known in U.S.A. as red brass and containing 85 per cent. copper, 5 per cent. tin, 5 per cent. zinc and 5 per cent. lead, should be poured between 1,100 and 1,200 deg. C., dependiny on the size and mass. The alloy known as T.F.F.4, which is for all practical purposes 88 Cu, 10 Sn, 2 Zn, plus traces of phosphorus, has a pouring temperature about 60 deg. C. lower than straight 88 Cu, 10 Sn, 2 Zn.

Rejects due to incorrect pouring temperatures are more numerous than is generally realised. They are usually much more serious when arising from too high a pouring temperature than are those due to cold-pouring. The latter will cause drawn areas at the junction of thick and thin sections and at the junction of runner and riser gates; small blow holes on upper surfaces, revealed after machining, and a tendency to





show hair-line cracks along the crystal boundaries.

The effect of too high a pouring temperature is to cause inter-dendritic cavities. If the temperature be excessively high, it may result in very pronounced cavities being formed under the skin, which are only revealed on machining. More often it shows as a rough, speckled surface on the roughing cut, and as minute cavities on the finishing cut or polished surface. In some cases it may not even be visible to the naked eye, but will cause the casting to leak under pressure.

An examination of the fracture is an excellent guide as to whether the temperature has been too high. Correctly-cast gun metal has a dense, golden, crystalline structure. When cast too hot, the fracture may show a mixed blue, gold and red colour, with the crystal structure scarcely, if at all, visible. Should such a fracture be examined under low-power magnification, it will show a network of inter-dendritic cavities closely connected one with another. Needless to say, metal in this condition always leaks on machined surfaces when subjected to pressure tests.

PHOSPHOR BRONZE

The extremely fluid character of the medium and high phosphor bronzes, together with their very wide solidifying range, calls for a somewhat different gating technique. It is usually advis-

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* A Paper which as an "Exchange Paper" with the South African Branch was read before the Lancashire Branch of the Institute of British Foundrymen, Mr. A. L. Key presiding.

able to run from, or at least near, the top of the mould, in order to assist progressive solidification from the bottom upwards. With large work, where the design may be such as to make top running impracticable, a series of gates will do much to prevent the formation of excessively hot regions in the lower parts of the job.

Fig. 5 illustrates a method of gating gland rings and similar castings. It will be seen that the runner gate follows much the same lines as would be used for cast iron. For a small ring, one feeding riser only is necessary, and should be placed near the runner so as to ensure it being filled with reasonably-hot metal. As the diameter increases, so must the number of feeding risers, one being sufficient up to about 10 in. in dia., two from 10 to 20 in., and three from 20 to 30 in.

Fig. 6 illustrates another type of fairly large casting which, owing to its particular shape, is

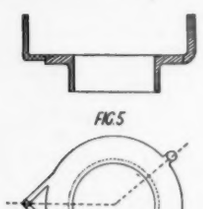


FIG.5

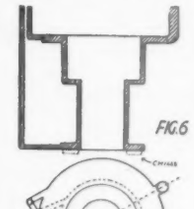


FIG.6

not suitable for gating from the top. In this instance two downgates are employed, the first entering the bottom flange, and when the mould is almost full the plug is lifted off the second gate, allowing hot metal to enter into the top flange. When gating in this manner, it is desirable to chill the face of the bottom flange heavily, to ensure it solidifying prior to the side walls. Heavy flow-off risers are employed to take care of the solidification shrinkage of the upper portion of the casting.

Excepting the very small work, it is preferable to use large runner bushes, such as are employed for cast iron, and almost to cover the gate with a piece of copper plate or strip, which will allow the bush to be filled almost instantaneously. Plugs can, of course, be used if desired, but, owing to the fluid nature of the metal, there is a tendency for them to leak, particularly when dry-sand runner bushes are used.

Pouring Temperatures

For important castings, the pouring temperature is more critical than that of any of the commonly used non-ferrous alloys. Examination of the fracture is an excellent guide as to whether or not the correct temperature has been used. When correctly cast, the fracture will show a dense structure, bluish-white in colour in the thin section; the thicker ones will have a dense outer skin of similar colour, the interior being golden with the crystal structure very clearly defined. With incorrect temperature, instead of a golden crystalline interior, there is a fracture showing mixed colours of bluish-grey, yellow and red, with the crystal boundaries invisible.

There are so many variable factors which govern the casting temperature of the phosphor-bronzes that no hard and fast rules can be established. The following figures will, however, serve as a useful guide: Small and medium castings having wall thickness up to about ½ in. and poured in low phosphorus alloys, 1,120 to 1,150 deg. C. For castings of similar size and mass, poured in high phosphorus alloys, 1,070 to 1,100 deg. C. For wall thicknesses from ½ in. to 1 in., the requisite temperatures will be between 1,090 and 1,120 deg. C. for the former alloys, and between 1,025 and 1,070 deg. C. for the latter group.

YELLOW BRASS

Gating for yellow brass follows the practice indicated for the gun metals. It has, however, a greater solidification shrinkage and therefore requires larger feeders. Many yellow brass castings are of thin section and comparatively large in area, and on work of this character, a high pouring temperature must be used. For this reason, it is desirable on work of large surface area to skin-dry the runner gates in order to prevent scabbing and erosion of the sand. The ingates should be well distributed and be placed to enter as near as possible into the heavier sections as illustrated at AA in Fig. 7, otherwise shrinkage cavities may occur at the points BB.

Risers used to feed bosses, etc., should be enlarged almost down to the casting as shown in Fig. 8. It is sometimes difficult on small work of this nature, where several castings are made in one box, to accommodate an adequate number of risers and runner bushes. An alternative method, and one which often gives superior results, is to place separate direct runner gates on to each casting. The hot metal, passing through them, prolongs the solidification and promotes good feeding.

Pouring Temperatures

The pouring temperature of the brasses is not nearly so critical as is the case with tin bronzes. High percentages of zinc prevent the absorption of reducing gases during melting, thus the speckled gas-holed appearance, which often causes rejection of gun-metal castings, is entirely absent. The pyrometer is therefore not often used, although unnecessary high temperature causes greater zinc losses, increased liquid shrinkage, and an increased tendency to erode the mould, particularly in the runner gate.

MANGANESE BRONZE

As quite a large number of non-ferrous foundrymen fight shy of this metal, there may be some excuse for the ferrous foundryman refusing to handle it. Successfully to cast the metal, a very highly-developed gating technique is necessary. The alloy must enter the mould entirely free from turbulence and, furthermore, any oxide formed in the runner gate has to be prevented from passing into the casting, as, once oxide has been formed, it is never reduced or re-absorbed by the metal. The solidifica-

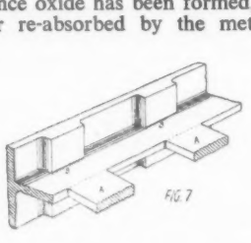


FIG.7

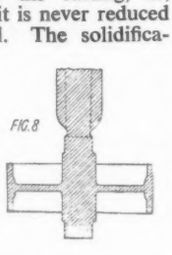


FIG.8

tion shrinker is also extremely high and ample provision must be made for feeding, and for ensuring directional solidification towards the feeding heads.

Excepting for extremely thin work, very slow pouring should be adopted, as quick pouring will always tend to create turbulence. For the same reason the metal must enter from the bottom of the mould, or at least on the lowest level. Any cascading effect will certainly cause dross inclusions. It is a decided advantage to arrange, wherever possible, for the runner to enter immediately under a feeding riser so that the flow may be observed during casting and, furthermore, if small particles of dross are formed, they may be piloted up the riser by means of a mild steel rod.

The runner gates must also be so designed as to avoid any jet-like effect being given to the metal as it passes through them. When a number of gates are fed from a larger one, special attention should be given to surface friction which may cause an increase in the speed of the metal passing through the centre of the small gates. Another important point when dealing with multi-gating is the prevention of an increase in pressure being given to metal in the small gates situated nearest to the main downgate. Dross traps and dross sumps are also used extensively on larger work, and such a trap is shown in Fig. 9. It is readily formed by bridging the gate with a core at A. It is also very desirable slightly to choke the gate at the runner-bush end by means of a core as shown in Fig. 9.

Fig. 10 illustrates a method of gating that can be applied to small and medium shallow castings. Here the metal first enters the bottom of a feeding riser from which it flows very quietly into the mould.

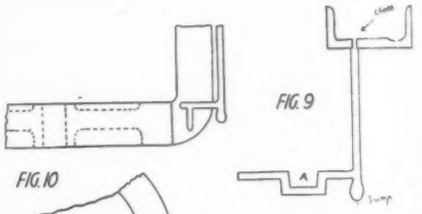


FIG.9

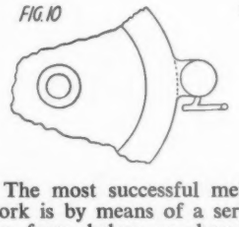


FIG.10

The most successful method of gating deep work is by means of a series of runners entering from below as shown in Fig. 11. The vertical runners increase slightly in cross-sectional area as they approach the casting. Gating a large casting in this manner causes the metal in the lower flange to solidify later than the walls of the casting, with disastrous results, unless special precautions be taken to hasten the solidification. The method most readily applied is the placing of cast-iron or copper chills on the base between the gates.

Pouring Temperatures

As with yellow brass, the density of manganese bronze is very little affected by pouring temperature. As, however, high temperature causes the shrinkage to increase, especially near the runner gates and near severe changes of section, and also increases the dross-forming tendency, all castings should be poured as cool as possible, having due regard to the avoidance of mis-runs. About 1,000 deg. C. is a good average temperature which may be varied 50 deg. C. or so in either direction, according to the size and mass of the casting.

ALUMINIUM BRONZE

The main problems to be met in casting the alloys under this heading are the prevention of oxide inclusions and drawn areas, problems which can only be solved by correct gating technique. The apparent solidification shrinkage is very high; therefore, large risers and feeding heads are essential. The latter may, in extreme cases, have to be considerably larger than the casting. As a general rule the methods described for manganese bronze can be applied, but it is even more important not to allow disturbance of the metal surface as it fills the mould. The oxidised skin should lap gently to the sides as the metal quietly rises. On important work, the slightest ripple may be sufficient to cause rejection.

Disc-type work generally lends itself to casting on edge as shown in Fig. 12. Light chilling near the base, as illustrated by the dotted lines, will

be a decided advantage, as it will counteract the tendency to prolonged solidification due to the gates superheating the base of the mould.

Castings resembling the design shown in Fig. 13 are more suitable for casting on the flat, when a heavy feeding riser can be used to take care of the shrinkage in the boss. In all cases, where suitable arrangement can be made for feeding, greater soundness can usually be obtained in bosses and other heavy sections by leaving out the centre core and casting such masses solid. Should coring be essential, chills may have to be resorted to.

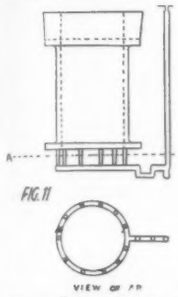


FIG. 11

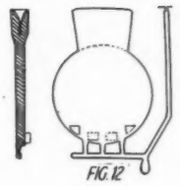


FIG. 12

A useful point to bear in mind when dealing with aluminium bronze and, indeed, with all the high-shrinkage alloys, is that hot metal poured into feeding heads and risers considerably improves their efficiency, but when applying the practice to the dross-forming alloys, the metal must be poured in with a very short stream, or oxide may be carried down into the casting.

Pouring Temperature.—The average range of castings made in aluminium bronze can be poured between 1,170 and 1,200 deg. C. but special massive ones may be poured considerably lower.

ALUMINIUM ALLOYS

The commonly-cast aluminium alloys, especially the high silicon ones known as "Alpax," "Wilmill," etc., can be regarded as easy to cast by the average foundryman and call for no special comment. Into quite a different category enter the high-duty alloys such as "Y"-alloy and their derivatives—R.R.50, R.R.53, Ceralumin, etc. All these alloys possess high solidification shrinkage and, due to their magnesium content, dross-forming tendencies.

Taken generally, it is desirable to use the multi-method of gating so as to avoid excessive overheating of one part of the mould, and to assist in levelling up the solidification. Bottom gating, because it reduces turbulence, is usually more successful, and pistons, liners, etc., can be cast with a continuous runner down the side of the mould, such as is used by die-casters. This type of runner also serves to supply hot feed metal to the upper part of the mould. A suggested method of multi-gating is given in Fig. 14. The feeding knobs, adjacent to the entrance of each ingate, are noteworthy. On deep work of a similar nature, it is often desirable to chill the base of the casting lightly in order to control the direction of solidification towards the feeders.

Pouring Temperatures

The aluminium alloys in general should be poured as low as possible consistent with obtaining a finished casting free from cold-shuts and trapped air bubbles. About 700 deg. C. is an average figure, which may be lowered to 670 deg. C. for massive castings and raised to 780 deg. C. or so for very thin ones. With the high-silicon alloys, the actual pouring temperature is controlled to some extent by the modifying temperature which, when using metallic sodium, is standardised at about 760 deg. C. Allowing a modification period of 2 minutes, a pouring range of 700 to 725 deg. C. is usually obtained.

Very thin castings of comparatively large area may be found difficult to run completely within the range, and for this category it is often found desirable to modify at 20 or 30 deg. above the recommended temperature. On very important work of a repetition character, one should obtain the correct temperature by trial in order to standardise it for future use—a procedure which should also be applied to almost all non-ferrous work of a similar character.

NICKEL-COPPER ALLOYS

While gating and pouring temperatures of the high-nickel alloys are not the most important consideration in the successful production of good castings, they are, nevertheless, worthy of serious consideration if scrap is to be avoided. The difficulties involved are largely due to the extremely short solidification range, the fairly high solidification shrinkage, and the extremely high pouring temperatures.

The main consideration to bear in mind is the provision of adequate feeding gates. At the same time one should remember the difficulties involved in removing the heads and risers of the high nickel alloy group by means of the ordinary dressing shop equipment, and design the gates accordingly.

A runner-gate, small enough to be kept choked and entering *via* the risers, as is sometimes used in manganese-bronze practice, gives the best results. Owing to the much shorter freezing range, the runner must, however, be considerably larger and very similar in size to that used in iron foundry practice. An example is given in Fig. 15 which shows a short, double-flanged pipe. The runners passing through the heavy feeding risers ensure very hot metal rising up into them and, therefore, efficient feeding is assured.

Pouring Temperatures

Broadly speaking, one should pour as hot as possible, but, of course, stewing in the furnace in order to make sure of obtaining a high temperature is fatal. Owing to the very high temperatures used it is difficult to determine them satisfactorily, although they can, of course, be obtained by means of a protected thermo-couple, but the time lag is a drawback. The approximate casting temperature of the 70:30 Cu-Ni alloy is about 1,400 deg. C., and the 30:70 Cu-Ni alloy (Monel metal type) is about 1,540 deg. C. As a general rule, the more adequate the feeding, the wider is the pouring range.

Finally, a word of warning against the "foundryman's" cure for porosity—increasing

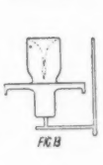


FIG. 13

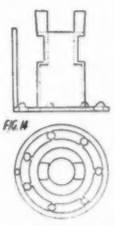


FIG. 14

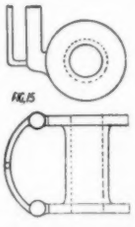


FIG. 15

the height of the gates. This is usually described as "giving pressure," but unfortunately very often it does more harm than good. What is essential is the maintenance of a liquid passage of metal from the head to the casting until the latter has become solid, and this can usually only be accomplished by increasing the mass of the risers and bringing the head as near to the casting as possible.

All-Scrap Charges in the Open-Hearth

Writing on the subject of "Uses and Metallurgy of Ferrous Scrap Metals," M. W. Von Bernewitz points out that the scrap for a Pacific Coast basic open-hearth fired with oil was obtained from railroads, mines, dredges, smelters, oil fields, shipyards, and machine shops. An all-scrap charge, he says, is severe on a furnace, but this one ran 411 heats before it was rebuilt.

Sheffield Metallurgical Association

ANNUAL MEETING

The annual meeting of the Sheffield Metallurgical Association was held at Sheffield on January 16, when Mr. H. H. L. Lockley was elected President.

Other officers of the Association, elected for the year 1940, were:—*Vice-Presidents,* Messrs. H. H. Burton, J. A. Jones, W. E. Bardgett and Dr. E. Gregory; *Hon. Treasurer,* Mr. R. Staton; *Secretary,* Mr. L. Rotherham; *Librarian,* Mr. T. H. Arnold; *Proceedings Secretary,* Dr. A. H. Jay; *Council,* Prof. J. H. Andrew, Messrs. A. Allison, W. H. Bailey, G. Glenn, W. Heselwood, W. Lister, Dr. S. A. Main, D. A. Oliver, G. Stanfield, and J. Woolman; *Auditors,* Messrs. Holmes, Widlake and Gibson.

A hearty vote of thanks was accorded to the retiring President (Mr. R. C. Tucker) for his services, on the motion of Dr. S. A. Main, seconded by Mr. J. Woolman.

MR. TUCKER, in vacating office, remarked with pleasure on the fact that the activities of the Association were dislocated for but a very short time when the war broke out. From what he could hear, they had resumed much more quickly than those of the majority of other technical societies, and he expressed thanks to the Council and other members for carrying on during a difficult and worrying time.

It was announced that a joint meeting of the Association with the Iron and Steel Institute and the Sheffield Society of Engineers and Metallurgists would be held on February 20, and would be preceded by an informal dinner.

Importation of Aluminium

An Order placing aluminium and certain aluminium products upon the list of goods prohibited from importation into the United Kingdom except under licence comes into force to-day (February 1).

The object of the Order is to assist in regulating the supply of aluminium alloys and aluminium scrap so that the needs of the Services are satisfied, the export trade is maintained as far as possible, and metal is available to produce certain essential goods for home industries, while limiting for exchange reasons the import of aluminium for non-essential purposes. While the granting of licences will depend on the circumstances of each case, and the conditions ruling at the time, applications to import material for the manufacture of goods for export will generally be allowed.

No licences will be issued for the import of foil, which is defined as sheet, strip, etc., not exceeding 0.006 in. in thickness, and applications for licences to import sheet and strip should accordingly specify thickness.

Licences will be issued by the Import Licensing Department of the Board of Trade on the recommendation of the Aluminium Controller, Ministry of Supply. Applications for import licences should be submitted in duplicate direct to the Aluminium Controller, Ministry of Supply, Raven Hotel, Shrewsbury, Shropshire. Application forms may be obtained from the Import Licensing Department, Board of Trade, 25, Southampton Buildings, Chancery Lane, London, W.C.2, and the offices of H.M. Collectors of Customs and Excise. The direction at the head of the application form that it should be forwarded to the Import Licensing Department should be ignored.

Extension of Research

According to "Metals and Alloys," the number of industrial research groups in the metallurgical industry in U.S.A. increased by about 50 per cent. between 1927 and 1938 and in those groups during this period the total research personnel more than doubled, the increase, both relative and absolute, being considerably greater in the ferrous than in the non-ferrous field.

De-Enamelling of Vitreous Enamelled Steel and Sheet Iron*

By N. L. EVANS, B.Sc., A.I.C.

During the past few years, manufacturers of vitreous-enamelled domestic equipment, particularly gas stoves, geysers and similar articles made of mild steel or ingot iron, have shown great interest in processes for de-enamelling defective components. Such interest is naturally stimulated when the price of sheet steel stands at a high level and when components have been made by expensive pressing operations. If only a few additional parts of a kind are required, ability to de-enamel some which have been rejected for enamelling defects may save the trouble and expense of setting up dies in a press. Also enamelled parts of cookers, etc., which have been in service are now being de-enamelled in increasing quantities prior to re-conditioning for further use.

In the case of cast-iron components, shot-blasting is the only suitable process for de-enamelling. Any chemical which would remove the enamel is liable to impregnate the cast iron—which is a porous material—and so cause defects in the subsequent re-enamelling process.

On the other hand, blasting is unsuitable for the treatment of thin sheet steel components, on account of the distortion which it causes. A chemical method of de-enamelling is therefore essential. Among the reagents which have been tried are hydrochloric, sulphuric, chromic and hydrofluoric acids. All these possess such serious drawbacks as liability to attack the underlying metal, danger to the health of the operators, excessively slow action, or inefficiency. The only chemical which has proved successful is caustic soda. This is used either as a solution in water or in the molten condition. It appears to the author that each of these methods has its field of usefulness, so both will be described in this Paper.

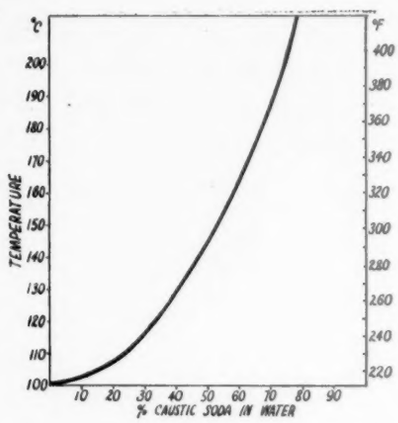


FIG. 1.—BOILING POINTS OF SOLUTIONS OF CAUSTIC SODA IN WATER.

Caustic-Soda Solution Method

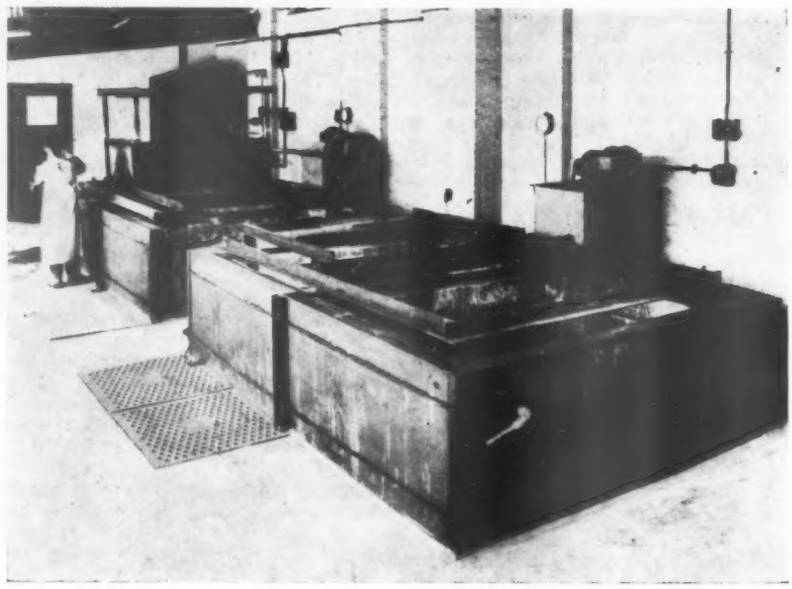
In 1933 S. W. Vickery[1] published details of a de-enamelling process which employed an American proprietary compound known as "Vitrosol." "Vitrosol" consists mainly of hydrated caustic soda. It is used as a boiling solution containing 12 lbs. of the compound per imperial gallon of water. The boiling point is said to be 270 to 280 deg. F. Reference to a curve (Fig. 1) of boiling points of acqueous solutions of commercial caustic soda shows that the recommended strength of "Vitrosol" is equivalent to about 43 per cent. caustic soda (NaOH).

The work to be de-enamelled is loaded into a crate and suspended in a tank of this solution, where it is agitated by means of a motor-driven eccentric. Vickery expresses the opinion that only a small proportion of the enamel is dissolved, and the remainder falls away as a sludge. The time taken to remove the enamel is 10 to 12 hours, after which the work is lifted out of the "Vitrosol" solution, and is swilled successively in hot water, 10 per cent. sulphuric-acid solution, and 0.7 per cent. sodium-carbonate solution. Evaporation losses from the "Vitrosol" tank are made up by a continuous trickle of water from the hot rinse tank.

This method is very similar to the one now being widely used in Great Britain, the plant being designed and manufactured by J. Gray & Sons, Limited (see Fig. 2).

Two tanks operate side by side, one containing the caustic-soda solution, and the other being a hot rinse tank. The caustic tank has a sump below the heater tubes, and in this the enamel sludge settles. The strength of the caustic-soda solution is 50 per cent., and it is operated a few degrees below its boiling point, in order to reduce evaporation losses. A 50 per cent. solution has a boiling point of about 292 deg. F., and the bath is operated at about 280 deg. The solution is heated by means of gas. Heater tubes are arranged horizontally, below the bottom level of the crate containing the work to be de-enamelled, and above the sludge sump. The addition of a small amount of sodium chromate to the solution has been recommended, as it was said to assist the settling of the sludge, but no adverse effects have been noticed in its absence.

The method of operating the plant is similar to the "Vitrosol" process. The parts to be de-enamelled are packed in mild-steel crates, and are lowered into the caustic solution, where the crate is given a to-and-fro movement by a suitable mechanism. The length of time required for removing the enamel varies from 8 to 24 hours, and is usually about 12 hours. It is necessary to supply a small but continuous flow of water, which may be taken from the rinse tank in order to minimise waste of caustic.



[*Courtesy J. Gray & Sons, Ltd.*

FIG. 2.—CAUSTIC SODA SOLUTION DE-ENAMELLING PLANT.

The important point to notice in this connection is that if the level of the caustic solution is permitted to fall considerably, a serious accident may occur if a cold-water tap is suddenly turned on and the water is allowed to flow rapidly into the caustic solution. Under such circumstances, the reaction is extremely violent, and the operators may be severely injured by splashes of hot strong caustic solution. This particular mishap is avoidable if the caustic tank is fitted with some simple device which will automatically maintain the level of the solution.

When the de-enamelling process is completed, the crate is lifted out of the caustic solution, and rinsed in the hot water rinse tank. The work is then unloaded from the crate, and passed to the scouring tanks, where it is sub-

* Paper presented to the Midland Section of the Institute of Vitreous Enamellers. The author is on the staff of the Research Department of Imperial Chemical Industries, Ltd., at Northwich.

jected to wire brushing to remove any residual enamel and the coating of black scum which is usually present. After this it is given a neutralising dip in dilute hydrochloric acid, then in dilute sodium-carbonate solution, after which it is ready to be processed for re-enamelling.

The enamel which is removed from the parts under treatment falls into the sump of the caustic tank in the form of a sludge, which has to be removed at intervals of about a week. This is accomplished by allowing the sludge to settle and the tank to cool down and then pumping the clear liquor into the adjoining rinse tank which has been emptied to receive it. The sludge is then diluted with water, well stirred by a jet of steam or compressed air, and pumped to waste by means of a Girdlestone or similar pump. It has been shown in practice that it is highly dangerous to permit a workman to get into the tank and shovel the sludge out.

Some users of this process go to the trouble of washing the sludge before disposing of it. This is desirable, in order to minimise any danger due to the presence of free caustic. If

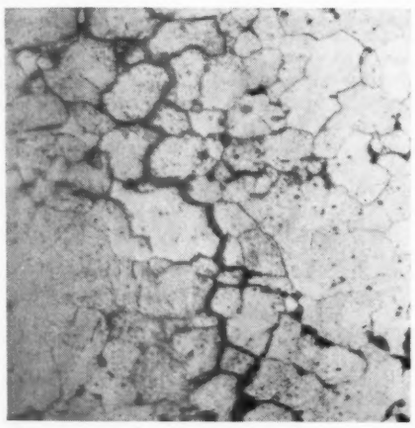


FIG. 3.—CAUSTIC EMBRITTLEMENT CRACK IN MILD STEEL, THE CRACK FOLLOWING THE GRAIN BOUNDARIES. ETCHED. × 500.

the sludge is to be dumped on waste ground, free caustic makes it unpleasant to handle, and a possible source of danger to children and animals who may gain access to it. A further precaution is to neutralise the sludge by treating it with waste pickle acid.

Construction of Tank

The construction of the tank for the caustic solution demands special attention. It should be made of mild-steel plate, about ¼ in. thick, preferably by the electric arc process. There should be a finishing run of weld metal on the inside of the tank, in order that there may be no crevices into which the caustic solution can penetrate.

Caustic Embrittlement

After all welding has been completed, the tank should be stress-relieved by heating to 650 deg. C. Unless this is done, there is a strong probability that cracks will develop in the neighbourhood of the welds. Several instances have come to the author's notice of failure along the corner welds, or of leakage of caustic into the heater tubes, putting the burners out of action. These cracks are explained by an effect known as caustic embrittlement. If mild steel, while in a stressed condition, is exposed to the action of caustic-soda solutions of between 35 and 70 per cent. strength at a temperature above 70 deg. C. (158 deg. F.), the physical properties of the steel deteriorate and cracking occurs.

Caustic embrittlement cracks are readily distinguishable from normal tensile or fatigue fractures, because they follow the boundaries of the crystal grains, whereas fatigue cracks are invariably trans-crystalline. The risk of this type of failure occurring may be completely eliminated by subjecting the tank to the stress-relieving treatment referred to above, and no tank should be put into service with 50 per cent. caustic solution without having been so treated.

Photomicrographs of typical structures embodying the two types of cracks are reproduced in Figs. 3 and 4.

Maintaining Strength of Solution

Many attempts have been made to devise chemical methods of testing the strength of the caustic-soda solution in order to control the additions of fresh caustic to the bath. The determination of free caustic in the presence of silicates and aluminates could possibly be carried out by a potentiometric titration, but the more usual method is to carry out a double titration of the caustic solution by hydrochloric acid, first to the phenolphthalein endpoint and then to the methyl-orange endpoint, and then determine silica and alumina gravimetrically to correct the titration and find the so-called "free" NaOH.

Certain assumptions are made in this method for which there is no justification, and as the procedure occupies a whole day, the results are out of date by the time the analysis is finished. In the author's opinion it is far simpler and more satisfactory to find by experiment how much fresh caustic needs to be added to the bath daily in order to compensate for the de-enamelling of a known area of enamelled ware. It is unnecessary to control the strength of the solution within very fine limits, and the workman operating the plant is better able to understand the regular daily addition of a definite weight of caustic soda, than a varying quantity depending on the results of a laboratory test.

It is understood that Messrs. Gray now recommend that caustic-soda additions should only be made when the sludge is removed from the tank, and not (as hitherto) prior to each batch of work going in for treatment.

Molten Caustic-Soda Method

Turning now to a consideration of the molten caustic-soda method of de-enamelling, one is faced with the need for a more elaborate and costly plant, but the de-enamelling operation instead of requiring 12 hrs. requires only 5 min. The caustic soda is kept at a temperature of 500 to 600 deg. C.

A description of one of the earlier plants of this type was given by F. L. Prentiss,[2] who described a design by the American General Electric Company. This consists of a steel tank 78 in. by 36 in. by 60 in. deep and 1½ in. wall thickness. It is fitted with external electric heaters round the sides. Underneath the tank is a safety tray with drain holes leading to an emergency tank in case of failure of the main tank.

The tank is well insulated and has an insulated lid. The electrical unit is three-phase, 60 cycle, rated at 125 kw., 220-volt capacity. The plant is said to operate 8 hrs. a day, and can be operated for 10 hrs., the remainder of the 24-hr. period being required for rejuvenation. De-enamelling in a day's operation is limited to the removal of an amount of enamel not in excess of 10 per cent. of the weight of caustic in the tank. A daily addition of flake caustic soda is made, to bring the level to within 8 or 9 in. of the top of the tank.

After removal of the articles from the tank, caustic and sludge are washed off in a tank of boiling water heated with an open-ended steam coil (see later remarks on this subject; boiling water may be dangerous for this purpose). This is followed by a dip in 10 per cent. hydrochloric acid, clean water and a neutralising rinse in soda solution.

Most of the thick sludge formed by the partly dissolved enamel settles in a basket set in the bottom of the tank, and this is lifted out by a hoist. The remaining sludge is removed from the bottom of the tank with a scoop. The temperature of the bath is reduced during sludge removal. The operator is protected by a steel-framed glass shield, reaching 3 ft. 6¾ in. above the top of the tank.

This plant was operated by the Youngstown Pressed Steel Company, manufacturers of electrically driven wash-tubs. It dealt with 100 tubs, with a total enamelled area of 1,800 sq. ft., per 8-hr. day. It will be noted that the tubs are bulky articles, and only three could be immersed in the tank at a time. This illustrates the most obvious advantage of the molten caustic process over the caustic solution process. The latter is satisfactory, though slow when flat plates are to be de-enamelled, and a very large number of them can be packed in a crate for treating at the same time.

A batch of work needs practically no supervision for 12 hours, and gas is the main item of cost. When bulky articles are to be dealt with

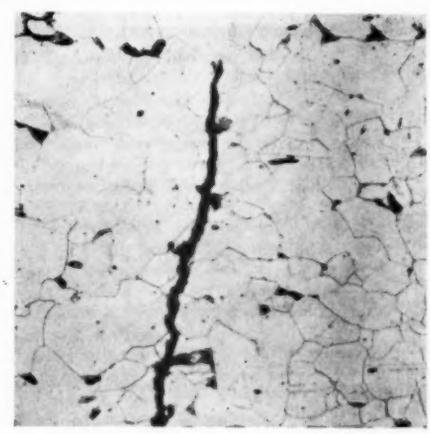


FIG. 4.—FATIGUE CRACK IN MILD STEEL, THE CRACK PASSING THROUGH THE CRYSTAL GRAINS. ETCHED. × 200.

and only one or two can be immersed in the caustic bath at a time, the cost of gas per square foot of surface de-enamelled is prohibitive. The author recently saw one instance of a large sink and draining-board unit, only half of which could be immersed in the caustic solution at a time. After 12 hours it was necessary to reverse it to de-enamel the other end, so that the plant was completely occupied with that one article for 24 hours. By using molten caustic soda the job would be completed in 10 minutes.

(To be continued.)

REFERENCES

[1] "De-enamelling Sheet Iron Shapes," S. W. Vickery, Journal of the Canadian Ceramic Society, Vol. 2 (1933), p. 47.

[2] "Enamelling and De-enamelling Feature Finishing of Washing Machine Tubs," F. L. Prentiss, "The Iron Age." *See* FOUNDRY TRADE JOURNAL, Vol. 52 (1935), p. 384.

Austenitic Cast Irons

An investigation by J. GALIBOURG and P. LAURENT in "Comptes Rendus," on the effect of thermal cycles (− 195 to 1,100 deg.) on the mechanical and magnetic properties and micrographic appearance of four austenitic cast irons (total C 2.41-3.33, graphitic C 2.16-2.65, Si 1.89-1.97 per cent.) shows that the martensite transformation occurs in one cast iron with Mn 1.00, Cr 2.20, Ni 20.69 per cent. on cooling below − 60 deg.; the reverse change occurs at above 460 deg., giving austenite which retains the form of the martensitic crystals. Another iron with Mn 1.58, Cr 2.51, Cu 5.23, Ni 14.86 undergoes similar changes, martensite being formed at under 50 deg. The other irons with Mn 8.31, 1.55; Ni 10.60, 32.67 per cent. remain in the austenitic condition. The occurrence of the martensite transformation is dependent on the previous heat-treatment.

Control of Enamel Slips*

By R. E. VIDAL

The Role of Clay

Quite obviously, the starting point in the care of enamel slip is to see that the slip is correctly milled. The presumption is that the frit employed is suitable for the purpose required, and that great care is taken to weigh out correctly the various mill additions.

Clay is practically essential in the grinding of wet-process enamels in order to prevent settling of the finely-ground frit particles. Only certain clear glazes are milled without clay, as in these enamels clay tends to cloud the glaze. There are so-called clear clays, but even in small amounts they incline to contribute some slight opacity.

The selection of clay is an important consideration, though unfortunately there seem to be no simple tests for determining the suspension qualities of clay. Clay should be highly plastic and fine-grained and should not contain impurities such as mica or organic materials. These impurities are harmful to the fired surface, leading to pitting or scumming. Also, by dilution with sandy, non-plastic material, impurities may reduce the suspending qualities of the clay. It is therefore recommended that clay be procured from some reliable source, preferably one recommended by manufacturers of frit. In some cases, small additions of bentonite are used together with clay.

Bentonite is highly colloidal material, and because of its colloidal properties smaller amounts of clay can be used than if clay alone is employed. This is desirable in acid-resisting enamels, where clay tends to reduce the acid-resistance. Bentonite is not usually used in excess of one-quarter per cent., and even this small percentage not only assists in keeping the finely-ground frit particles in suspension, but also acts as a setting-up agent.

Electrolytes

To assist the clay in keeping the enamel in suspension, electrolytes, or setting-up agents are used frequently. These include such materials as borax, magnesium carbonate, sodium carbonate, ammonium carbonate, sodium nitrite, potassium carbonate, sodium aluminate and many others. Certain acids can be used, such as sulphuric and hydrochloric acids. Sodium nitrite and sodium aluminate also act as rust preventives.

The function of these electrolytes is to keep the solids in the slip in a state of dispersion, that is, suspension. This is accomplished by their imparting a surface charge to the particles of solids contained in the slip. A like charge is imparted to each particle, thus causing them to repel one another electrostatically, thereby keeping the slip in a state of constant dispersion.

The colouring oxide additions do not affect greatly the condition of the slip, although certain opacifying agents such as titanium oxide do tend to increase the set-up. The most commonly used opacifying agents, such as tin oxide or zirconium base opacifiers, do not seem to alter the set of the enamels, but some of the substitute opacifiers, generally of continental origin, which have in some cases an alkaline content, do exert a setting-up effect.

Water Hardness

The relative hardness or softness of the water used has a definite bearing on the condition of the slip. Very hard water contains a relatively high percentage of carbonate of magnesium and calcium which affects the amounts of soluble salts which are normally leached out of the frit in milling. These salts have an electrolytic action on the colloidal condition of the clay, and any variation in their quantity therefore affects the ultimate set of the enamel. Normally, hard water can be compensated for, by adjusting the amount of set-up agents employed. In exceptional cases, it may be advisable to abandon the use of local water and use rain water or distilled water instead. An abnormal content of iron salts in the water, while not affecting the consistency of the enamel slip, may nevertheless be objectionable by causing copperheading or affecting the colour of the burned ware. In such cases as this, there is no remedy but to seek other sources of water supply.

Effect of Milling Conditions

Apart from the increased wear and tear of the mill due to under-charging, this practice leads to pounding which will result in the heating up of the slip. Heating imparts a false set-up due to the stiffening action which it exerts on clay. Pounding may also produce sponginess due to minute particles of air being imprisoned in the excessively viscous slip.

Overloading of mills leads to inefficient grinding but seems to have little effect on the final consistency of the milled enamel. There is, however, the danger of contamination. Enamel slip can readily be affected by the inclusion of particles of porcelain worn from the mill lining of the pebbles due to the pounding of an under-charged mill or the excessively long time an overcharged mill takes to grind down to proper fineness. This can cause specks or scumming or other enamel troubles.

Generally speaking, a mill should be filled up to the half-way mark with balls or pebbles, and then up to the three-quarter mark with the frit and mill additions. The speed of rotation should be such that maximum grinding efficiency is obtained without pounding or heating. The ideal temperature of enamel during milling is between 65 and 80 deg. F. In some cases it is necessary to use water-cooled mills.

Before unloading slip from the mill, it should be checked for proper fineness, as this greatly influences the behaviour of the enamel in production.

Fineness Tests

Quite a usual test of fineness is to wash a 50-c.c. sample of the milled enamel through a 150- or 200-mesh sieve, dry the residue and thoroughly agitate to remove all fine particles. The remaining particles of frit are then weighed or measured, to give a measure of fineness. If a 200-mesh sieve be used, and the residue weighed, the following fineness has been found suitable for this country:—

Sheet-steel ground coats	...	10 to 12 grms.
Sheet-steel cover coats	...	4 to 7 grms.
Cast-iron ground coats	...	2 to 4 grms.
Cast-iron cover coats	...	8 to 10 grms.
Cast-iron direct on enamels		10 to 14 grms.

If only one cover coat is to be applied the enamel should be ground coarser than if two coats are intended.

The degree of fineness of the slip influences the consistency and the dipping and draining properties. The finer the enamel is milled, the greater will be the set-up, due not only to the finer particles, but also to the increased solvent action on the frit. A coarsely milled "steel" ground coat, while draining satisfactorily at first, loses set and workability rapidly and may develop "double draining" unless this is rectified by the addition of further setting-up agents.

Finely milled ground coats have a longer period of workability, but because of their "shortness" do not drain satisfactorily and may result in draining marks on the fired ware. Moreover, finely milled ground coats tend to burn off the edge of the ware and overfire more readily in the finish coat.

Fineness of grinding influences the speed of draining—a finely-ground enamel having a longer draining time than one more coarsely milled.

Cover Coats

As regards cover-coat enamels, which are generally sprayed (except in the case of the hollow-ware industry) the grinding fineness is not perhaps so influential on the workability as in ground coat. However, if a cover coat is too coarsely milled it will not fuse out smoothly. In general, enamels for spraying are ground as fine as is possible without inviting drying and burning troubles. Too fine grinding results in an enamel which has a low dry-film strength in the bisque stage which may cause tearing and crawling when fusing. It is nevertheless advisable to grind as fine as possible as the gloss, opacity and the ability of the enamel to fire out smoothly are all enhanced by fine grinding.

Enamels are usually sprayed at as high a consistency as will readily flow from the gun in an atomised state in order to achieve a dense, uniform coating. If the enamel is thin, it may run off the corners and edges of the ware, or build up in inverted flanges and result in chipping or crazing at these points. Also, it may spit when sprayed, resulting in an uneven finish or orange-peel effect.

The consistency of the enamel should not be confused with the specific gravity, although factors affecting the specific gravity do affect the consistency. Other factors, as well as water content, operate upon the consistency, but the gravity is directedly controlled by the amount of water present in the slip. The gravity is important as it gives a definite measure of the weight of actual enamel which will be deposited on the fired ware from a given wet weight which has been applied either by dipping or spraying.

Water Additions

The water addition to the mill should be such that no further water need be added to the slip when it is sent to production. This state of affairs cannot always be achieved in milling ground coats as conditions may call for such a large water content that satisfactory milling cannot be carried out. Towards the end of milling only, then, should water be added to bring the slip to proper dipping and draining condition.

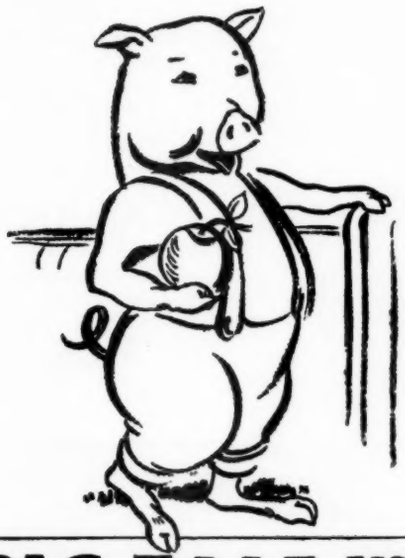
Before unloading the mill, therefore, tests should be carried out to ensure that the enamel is in the desired condition. Tests should be made of fineness, gravity and (if possible) consistency. Moreover, a fired sample should be put through, not only as a check on the above-mentioned tests, but also to determine that the colour is correct or if any contamination is present. Fineness tests have already been described, while gravity may be easily tested by weighing 50 or 100 c.c. volume of enamel slip.

Consistometers

Various forms of consistometers may be obtained, but the consistency may be quite simply determined by measuring the time a given volume takes to pass through a small orifice. The most suitable fineness, gravity and consistency should be determined for each enamel and adopted as standard and those standards adhered to.

After the control tests show that enamel is properly ground and of correct consistency and gravity, it should be unloaded and screened. Normally, screening is carried out by passing the slip through some form of sieve to remove

* Paper presented to the Scottish Section of the Institute of Vitreous Enamellers. The author is on the staff of Ferro Enamels, Limited.



PIG TALE No1

One little pig went to market..

Our advertising agents have assured us that Pig Iron advertisements are becoming stereotyped.

They suggested that one fracture looked much like another in the nude or even in microphotographs—and anyhow they didn't see how all those castings could be made from one pig however much it was magnified.

In fact they thought that a little flippancy would do more to convince the foundry world that we were still alive and kicking, than a page of technicalities, however much sales propaganda we introduced.

Finally, they almost persuaded us that the quoted extract from the nursery rhyme was the first known reference to our special pigs. Well, we don't ask you to believe that—not in the "Foundry Trade Journal"—(we were in the "Pig & Whistle" at the time)—but at any rate this little pig has stayed in the market very successfully since 1880.

May we have your enquiries?—THE NAME OF COURSE IS

Warner's

WARNER AND CO., LTD.
CARGO FLEET
MIDDLESBROUGH-ON-TEES

coarse particles of unground frit. By far the most efficient form of screen is a "Roto-spray," not only because of the better screening so obtained, but also because of the large saving of labour obtained by this method. If there is any possibility of the enamel having come into contact with the iron of the mill shell or door frame, the slip should be passed over a magnetic separator. In passing it should be mentioned that it is most important that the door frames and running doors be protected from the grinding action of pebbles or balls.

Ageing

The enamel should be aged for a period of 24 to 48 hrs. after milling before it is sent to production. This is necessary to allow heat from milling to be dissipated and to permit the escape of any entrapped air bubbles from the slip. Due to either of these causes, the enamel may have a false set, and if water were added to remedy this, the slip would be too thin after maturity. During ageing and subsequent storage, the enamel should be kept in clean, covered rustless containers and the type of enamel distinctly indicated.

The foregoing covers control of the slip up to the time it leaves the mill room storage for issue to the production department.

Dip Tank Control

During production, loss of set in the enamel may be encountered in the dip tank, due to carry-over on the ware where soda-ash solution is used as a neutraliser in the pickling process. One theory is that the set of the enamel is dependent on the ratio of sodium oxide to boric oxide in the mill liquid. After several days' operation, the ratio may be increased by the sodium oxide thus carried over and thereby destroy the set. The best way to overcome this difficulty is to use a small percentage of borax in the neutraliser—one part of borax to ten parts of soda ash is the usual proportion.

When it is necessary to increase the set of enamel in the dip tank, a quantity of fresh enamel should be added to restore the set. If, however, no new enamel is available, a saturated solution of electrolytes may be added in small quantities. This doctoring is not the best practice, but at times is unavoidable. Where it is necessary to reduce the set slightly, a small addition of water will accomplish the desired effect though extreme care should be taken that this is not overdone. A dipping weight test should be taken before carrying on with production, if the set has to be adjusted in this manner.

In larger plants it is the practice to use the enamel reclaimed from the spray booths for first-coat work. Care is essential to see that such enamel is not contaminated with shop dust, and before remilling such enamel it should be well mixed with water and carefully screened through a rotary spray or ordinary screen and also passed over a magnetic separator to remove any fine particles of metal which may have become admixed during production.

Water Content Control

The control of the water content in ground-coat slips deserves special consideration. In most plants applying ground coat by dipping and draining, the weight of application is controlled by weighing a test panel of given size in either the wet or the dry state or both. If both the wet weight and the dry weight are known, the water content may be calculated by dividing the loss of weight (*i.e.*, the difference between the wet and dry weights) by the wet weight and multiplying by 100. Alternatively, the loss of weight could be obtained by thoroughly drying a given weight of slip, say 100 grms., which, although more accurate, is perhaps less convenient than the figures obtained from the test panel. To repeat, the calculation is as follows:—

$$\frac{\text{Loss of weight}}{\text{Original wet wght.}} \times 100 = \text{Per cent. water content.}$$

The best consistency and draining conditions are usually obtained with a water content calculated on the above basis, of between 36 and 40 per cent. These limits are too wide for any one plant, but depending on the type of ware, ground coat formula, local water conditions, mill additions and preference for a long or a short draining time, much closer limits could be set.

In conclusion, the necessity for scrupulous cleanliness of the mills, mill room, and enamel containers cannot be too strongly emphasised.

Charging Machines for Enamelling Ovens

There are many reasons for the increased use of mechanical charging equipment in recent years. Transportation of cumbersome loads by man-power is eliminated, resulting in increased production, while handling is simplified, and fatigue and labour costs reduced.

Mechanical charging machines—arranged for both hand and electric operation—are manufactured to meet a wide range of conditions. The swivel type is used where the load has to be transferred from a position out of line with the furnaces, since the forks can be turned through an arc of 180 deg. Machines have been arranged for completely automatic operation by electric push-button control, and for handling heavy loads over an extensive reach—up to 30 ft.

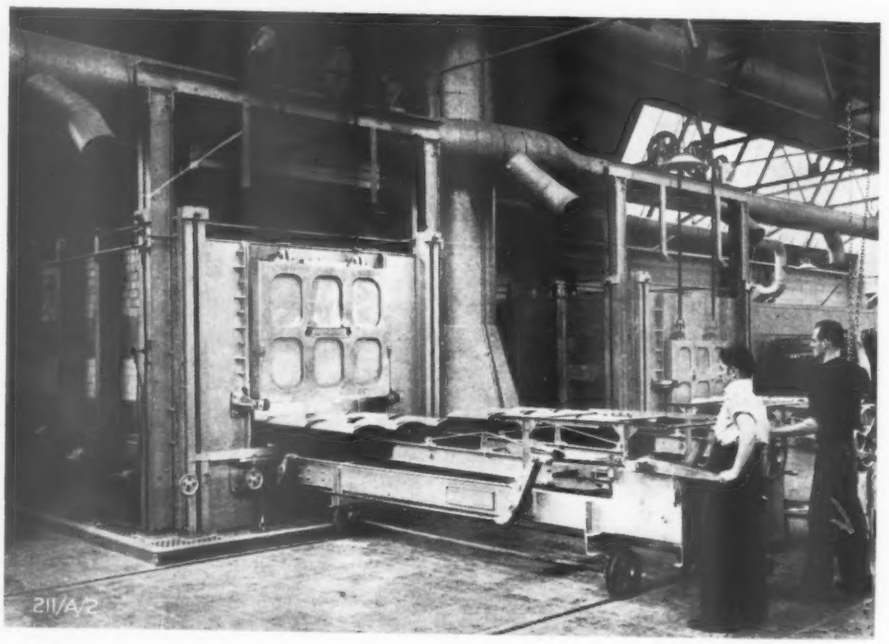


FIG. 1.—"DUPLEX" CHARGING MACHINE USED IN CONJUNCTION WITH AN "EQUI-RADIANT" ENAMELLING STOVE.

A Design for Speedy Handling

Rapidity and efficiency in handling the charge are essential factors in vitreous enamelling, and in this sphere, a special type of charging machine—the "Duplex" type—has been evolved. This charger consists of two single machines coupled together to form one unit, and by this means almost continuous operation is effected. The load which is to be treated is placed on one pair of forks, the load already under treatment being withdrawn from the furnace on the other. The new load may then be treated without delay.

Our illustration is of a typical example of a "Duplex" charging machine serving an "Equi-Radiant" enamelling furnace. This machine is 15 ft. long, 11 ft. 9 in. wide, and has a reach of 10 ft. 4 in. The forks are 2 ft. 9 in. above ground level, and the centres of the road wheels are 10 ft. apart. All the controls are conveniently grouped together at the back of the machine, and all movements are designed for easy manipulation. It will be seen that the use of this type of equipment, ensuring rapid loading and unloading, must result in increased production, and furthermore means a saving in fuel cost, since heat losses from the open door are reduced to a minimum.

The Incandescent Heat Company, Limited, of Cornwall Road, Smethwick, Birmingham, are manufacturers of the equipment described.

Developments in the Use of Tin

According to the fourth issue of "Tin and Its Uses" (issued by the International Tin Research and Development Council), a new "white-bronze" plating which challenges chromium in its resistance to tarnish, and is almost identical in colour and reflecting power to perfectly polished silver, has been developed. Photographs are reproduced which illustrate the brilliance and other attractive qualities of this new finish on taps, metal tea-sets and car fittings, and it is suggested that it will find extensive applications in reflectors for optical instruments, headlamps, shop fittings, and ornamental metal wares. The same publication states that thick and adherent tin linings can now be applied to large iron castings, used in the food industry, as a result of recent improvements in electroplating technique. These thick linings are far more serviceable than hot-dipped coatings. Still another application of electro-deposited tin is as a coating on metal surfaces in rubbing contact, such as pistons and piston-rings and bearing surfaces. The tin not only improves lubrication, but also eliminates abrasion during running-in processes.

PIG TALE N° 2

Pygmalion..

As soon as we saw this heading we asked our Advertising Agents if they were going high-brow. They replied "Not b———— likely" in the approved flower girl manner, and suggested that Pygmalion must have been an uncommonly good moulder, despite (?) the language with which he is unfortunately associated.

They wanted to know if your moulders and our 'PYGS' would give just as good results.

That struck us as "Pygmalion likely" if we may say so. Anyhow we have many letters from hard headed Foundry men bashfully informing us that they have fallen in love—with their castings. And as that is Pygmalion's claim to fame why should it not be yours too?

The moral in this amoral advertisement is to specify our 'PYGS' and thus avoid our language.

THE NAME OF COURSE IS

Warner's

May we have your enquiries?

WARNER & CO., LTD., CARGO FLEET
MIDDLESBROUGH-ON-TEES

The Week's News in Brief

Trade Talk

PIG-IRON production in the U.S.A. in 1939 totalled 31,533,370 tons. The 1938 figure was 18,782,236 tons.

THE AMERICAN IRON AND STEEL INSTITUTE is to hold its 49th general meeting at the Waldorf-Astoria, New York, on May 23 next.

THE STANDARD BRASS, IRON & STEEL FOUNDRIES, LIMITED, of Benoni, Transvaal, South Africa, have sent us a large monthly tear-off wall calendar. On each sheet is a picture of typical productions made by this firm.

THE FEDERATION OF MANUFACTURERS AND PRODUCERS OF GREAT BRITAIN have interviewed representatives of the Ministry of Supply and the Air Ministry and discussed the problems of assisting small manufacturers in obtaining work.

IN A LETTER to the Board of Trade dealing with premiums to be charged under Part II of the War Risks (Commodities) Insurance Act, the Federation of British Industries strongly urges that for one month, starting from March 3 next, the existing amounts at risk should be covered without payment of any additional premium.

THE engineering employers, at a conference in London, on February 6, are expected to give a definite reply to the application by the Amalgamated Engineering Union and the National Union of Foundry Workers for an all-round rise in wages of engineers of 10s. a week. The next day the employers will meet the Joint Trades Movement, covering all the other unions in the industry, to give a similar reply.

JUGOSLAVIA is concerned in regard to supplies of pig-iron. Although a large producer of iron ore, she is dependent on imports of pig-iron, since the national output is insufficient to cover the country's needs, in spite of the starting-up of new blast furnaces. Pig-iron demand has rapidly expanded with extensions in the country's heavy industries, and a shortage is being experienced owing to the difficulty of getting imports. During the first eight months of the current year imports were 24,000 metric tons, or barely half the tonnage imported during the same period of last year. The principal decline has been in supplies from Bohemia and Moravia. The problem of ensuring adequate supplies of raw materials to the heavy industries was the subject of a long conference at the Jugoslav Ministry of Commerce recently.

REFERRING to the export trade of the country at the meeting of Barclays Bank, Limited, in London, on January 24, Mr. Edwin Fisher (chairman) said we were in no doubt as to the vital part which this arm played when Britain was at war—a part which ranked among the foremost when we came to appraise and pass under review the strength of our national armoury. It was one thing to define an objective and another to devise the means to attain it. Control of both imports and exports was essential in wartime, in order that we might be able to use our external purchasing power to the best advantage and to ensure that the needs of the fighting forces were fully met. Although under a system of control a certain amount of freedom must be surrendered by the trading community, Mr. Fisher urged that control at its best should be so ordered as to cause a minimum of inconvenience and disturbance—control operated by persons who have understanding and who will not stifle trade by the imposition of dispensable formalities. Trade should be allowed to expand and develop, so far as may be, in a normal, healthy, and unrestricted fashion, subject only to that degree of control which the emergency of the times properly imposes. Economic strength would play such an impressive part in war that no opportunities must be lost in the solution of the problem of how to sell more and more goods abroad. The Government, the individual citizen, and the manufacturer all had their separate tasks to perform. The manufacturer, despite control and despite the difficulties of selling abroad under war conditions, retaining his initiative, would seek to gain a sure foothold in every available market. Essential as that was to-day, it would be of transcendent value in the days that lay ahead, when, the war over, we were called upon to face and deal with the many problems that must assuredly arise.

Personal

MR. A. ROEBUCK has been elected President of the Sheffield Society of Engineers and Metallurgists for the second year.

MR. P. MANSINE, until recently acting superintendent, has been appointed superintendent of the Newcastle Steel Works of the Broken Hill Proprietary Company, New South Wales.

MR. F. H. ALLMAN-WARD, chief engineer at the Mond Nickel Works, Clydach, Swansea Valley, for more than ten years, who is leaving to take up an appointment at Bristol, has been presented with a farewell gift on behalf of the works and office staff.

SIR ANDREW DUNCAN, President of the Board of Trade, and until recently chairman of the British Iron and Steel Federation, has been recommended by the Executive Committee of the City of London Conservative Association for adoption as National candidate to represent the City of London in Parliament in place of Sir Alan Anderson, who is about to retire.

Reports and Dividends

Braithwaite & Company, Engineers, Limited—Interim dividend of 2 per cent.

Herbert Morris, Limited—Dividend for the half-year to January 31 on the 5 per cent. (tax free) cumulative preference shares.

International Combustion, Limited—Net profit for the year ended September 30, before providing for taxation, £299,000; brought in, £21,510; dividend on the 6 per cent. cumulative preference shares, £9,000; interim dividend on the ordinary shares of 7½ per cent., £26,377; to reserve account, £50,000; to reserve for taxation, £135,000; final dividend on the ordinary shares of 12½ per cent., £43,962; cash bonus of 12½ per cent., £43,962; carried forward, £12,209.

New Companies

(From the Register compiled by Jordan & Sons, Limited, Company Registration Agents, 116 to 118, Chancery Lane, London, W.C.2.)

George Pizey & Son, Limited, Overton Road, Leyton, London, E.10—Capital £3,500. Solder manufacturers. Directors: R. D. G. Pizey and L. E. Fillmore.

Ferrostatics, Limited—Capital £3,000. Constructional and mechanical engineers, ironfounders, etc. Subscriber: H. J. Fellows, 13, Brampton Grove, Kenton, Middlesex.

Warren Bros. (Newhall), Limited—Capital £6,000. To take over the business of ironfounders, boiler makers, brassfounders and engineers carried on at Newhall, Derbyshire, as "Warren Bros." Directors: J. H., C. O. B., and Joseph H. Warren.

A New Foundry Residues Recovery Plant

(*Continued from page* 95.)

for easy disposal. The overflow water, after removal of colloids in a series of settling pits, can then be recirculated throughout the plant. Should a limited space be available, giving no room for settling pits, the de-watering of the sand and the recovery of water can be accomplished by means of a thickener unit.

A complete plant embodying the process described above, and having a capacity of 1 ton per hr., has been installed in the foundry of Shipham & Company, Limited, Trinity Brass and Copper Works, Hull, for the treatment of their residues, and has been operating for some months, with excellent results.

The equipment was designed, manufactured, and erected by The Wilfley Mining Machinery Company, Limited, Salisbury House, London, E.C.2, who have been responsible for a number of similar plants installed by leading brass founders, alloy manufacturers, and others all over the country.

Obituary

MR. A. C. BROWN, director of the Carntyne Steel Castings Company, Limited, Renfrew, has died.

MR. WILLIAM LIDGATE, who died recently, was for 60 years a patternmaker at the Staveley Coal and Iron Company, Limited. He was 83 years old.

THE DEATH has occurred of Mr. W. I. Peach, who for 33 years was manager of the forge and rolling mills of the Sheepbridge Coal & Iron Company, Limited. He was a member of the Iron and Steel Institute.

MR. FRANCIS SCOTT-SMITH died last month, aged 69, at his home in Harrogate. For many years he was managing director of Samuel Fox & Company, Limited, Stocksbridge. He was a former director of the United Steel Companies, Limited, and at one time was general manager of all the works owned or controlled by the United Steel Companies in the Sheffield district. Son of the late Mr. Francis B. Smith, of Sheffield, he was educated at Uppingham School. On leaving school he gained experience at the works of Cammell Laird & Company, Limited, passing through the shops and offices. He joined the staff of Samuel Fox & Company, at Stocksbridge, in May, 1894, remaining associated with the firm until his retirement in November, 1932. He joined the firm as assistant to the general manager, was general manager for more than 20 years, and was chairman at one time.

MR. HUBERT SPENCE-THOMAS, formerly of Whitchurch, Cardiff, the tinplate manufacturer, has died suddenly at Los Angeles, California, aged 69. Born in 1871, Mr. Spence-Thomas was the seventh son of the late Mr. Richard Thomas, founder of Richard Thomas & Company, Limited, the Welsh tinplate manufacturers. He was educated at Dulwich College, London, and started work at Lydbrook Tinplate Works at 16 years of age. In 1907 Mr. Spence-Thomas was made general manager of the Melingriffith Tinplate Works, Cardiff, which remained the centre of his activities for several years. He served on the Council of the Iron and Steel Institute and of the South Wales Institute of Engineers. He was a Past-President and honorary member of the South Wales Institute—a distinction which was bestowed in 1932 in recognition of his valuable service. In 1935 he was a member of the Institute of British Foundrymen's delegation to the American International Conference.

Contracts Open

Belfast, February 6—Iron; iron castings; bolts, spikes, etc.; springs, steel, and files; nails, screws, etc., for 12 months, for the Belfast and County Down Railway Company. The Storekeeper, Belfast Railway Terminus.

Birmingham, February 9—Supply and erection of three electrically-driven pumps having an output of 100,000 galls. per hr. each for handling river water, for the Electricity Department. Mr. F. Forrest, chief engineer, 14, Dale End, Birmingham, 4. (Fee £2, returnable.)

Forthcoming Events

FEBRUARY 5.

Royal Society of Arts:—"Metals as Engineering Materials," second of three Cantor Lectures, by Dr. C. H. Desch, at the R.S.A., John Adam Street, Adelphi, London, W.C.2, at 4 p.m.

FEBRUARY 8.

Institute of Metals (London Section):—"Some Considerations in the Training of Metallurgists," Paper by Dr. S. W. Smith, at Caxton Hall, Victoria Street, London, S.W.1, at 7 p.m.

FEBRUARY 9.

Manchester Association of Engineers:—Third Manchester Association of Engineers Annual Lecture: "Use of Models in Engineering," by Prof. A. H. Gibson, at College of Technology, Sackville Street, Manchester, at 7.30 p.m.

Institute of British Foundrymen

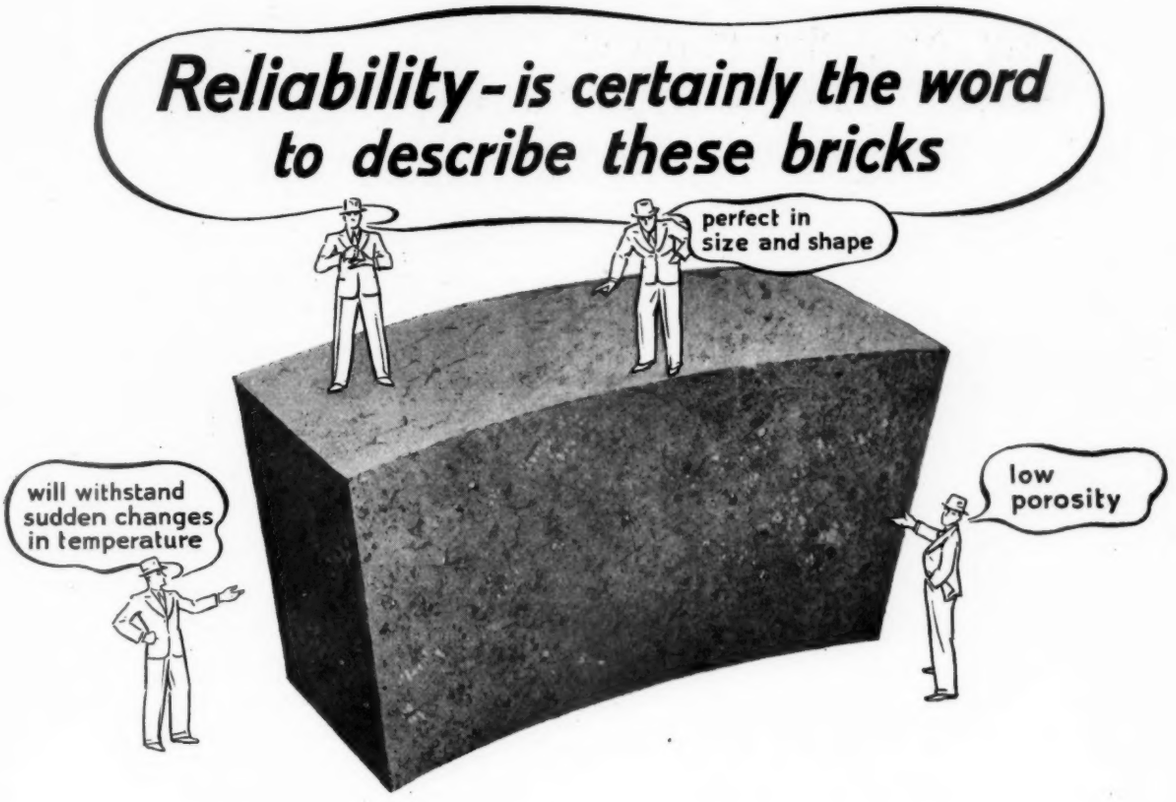
FEBRUARY 3.

Lancashire Branch:—Annual whist drive, dinner and dance, at the Grand Hotel, Manchester, commencing at 3.30 p.m.

FEBRUARY 10.

Scottish Branch:—"Making of Some Marine Auxiliary Castings," Paper by R. R. Cunningham, at Royal Technical College, George Street, Glasgow, at 3.30 p.m.

West Riding of Yorkshire Branch:—"Essential Details of Modern Foundry Control," Paper by H. Forrest, at Technical College, Bradford.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Raw Material Markets

Higher Prices for Pig-Iron and Iron and Steel Castings

The Minister of Supply has made the Control of Iron and Steel (No. 6) Order, which comes into force to-day (February 1) and supersedes the Control of Iron and Steel (No. 4) Order, made on November 1 last.

In substance the previous Order is unaltered, but attention is drawn to the narrowing of the scope of the provisions for exemption from licence contained in Direction (No. 1) attached to the Order, and to the price alterations.

The maximum prices fixed under the Order represent an addition of 3s. per ton in the case of pig-iron and £1 per ton in the case of semi-finished and heavy steel products, with corresponding adjustments in the prices of other finished products. These additions, as in the case of the additions made as from November 1, 1939, are for the purpose of meeting from a central fund the additional costs, including higher freight charges, which arise from importations of raw and semi-finished materials under war conditions. There are also some further adjustments in the prices of tinplates and iron castings. It is laid down that the price which shall rule for iron castings which have not been subjected to any process other than moulding, fettling, annealing or painting, shall be "the seller's latest price ruling in 1939 before September 1, 1939, with the addition of 8 per cent. plus 13s. 4d. per ton, or an equivalent percentage, and any appropriate extras set out in the related schedules for alloy additions." For steel castings, prices are those set out in the related schedules, plus 13s. 4d. a ton.

The new prices for iron and steel products, which now include fixed rates for certain ferro-alloys, have been incorporated in the list which appears on page 12.

There is quite a good demand for foundry iron in most districts, but, on the whole, more work is needed among foundries. The lighter works have not yet received substantial Government orders, although more are expected as munitions production increases. The major demand at present is, of course, for iron for steelmaking purposes, supplies of which are being taken up as they become available.

Pig-Iron

MIDDLESBROUGH—The call for supplies of pig-iron from local foundries is only moderate, and works will need a considerable amount of new business before they have satisfactory order-books. Midland producers are easily able to meet Cleveland users' requirements, and there has been no resumption of the production of local foundry iron. Ironmakers in this district are busily engaged in meeting the heavy call for iron for steelworks' use, and there is little likelihood of any relaxation in this respect for a long time to come. There is an insistent call for hematite, and consumption is on a good scale. Consumers are keen to accumulate reserve stocks, but the Control authorities' primary aim is to ensure that no user is left without supplies sufficient to permit a continuation of operations. Thus there is little or no chance of building up stocks in the present circumstances. The new price schedule, to come into operation as from to-day (Thursday), will not have any considerable effect on market conditions generally.

LANCASHIRE—Pig-iron prices will be advanced by 3s. per ton as from February 1, but the change will not have the same effect as it would have done in peacetime. Firms engaged on war work are the largest consumers, but there is now an improved demand from other users, and jobbing founders have slightly improved order-books, although, in common with light-castings makers and some textile machinists, they are not yet as well placed as they would desire. Good deliveries of hematite are being made and consumption is on a good scale.

MIDLANDS—The demand for pig-iron from most consuming works continues to be insistent, and, there being but a small surplus, the higher prices being introduced as from to-day will not appreciably affect the demand. Applications for licences for fresh supplies, if required for work of national importance, are given careful and sympathetic consideration, and, on the whole, there are few complaints regarding deliveries. High-phosphorus iron is generally available, but stocks are about non-existent. The position regarding hematite and low-phosphorus iron has recently improved, but every ton is quickly taken up.

SCOTLAND—As was expected, pig-iron prices have been advanced, and the price of No. 3 foundry is now 112s. 6d. per ton, f.o.t. furnaces. The demand is strong and outputs are being moved into consumption without delay. Intermittent working continues to be general in the light-castings trade, although some makers are better placed than others. Steelmaking irons are in heavy demand.

Coke

There is considerable pressure for deliveries of foundry coke, but ovens are keeping pace with their commitments and supplies are arriving at consumers' works with commendable regularity. Many users have been able to build up reserve stocks. For delivery to Birmingham and district, the current price of Durham best coke is 53s., and ovens are willing to book orders involving deliveries over the first half of the year, but all contracts are inclusive of a rise-and-fall clause, which protects makers against price fluctuations made by the Control authorities.

Steel

The maximum prices of steel as outlined in the Control of Iron and Steel (No. 4) Order have been raised by 20s. per ton in the case of semi-finished and heavy steel products, with effect from to-day. As has been stated in this journal from time to time, producers' costs have been steadily rising since the war began, so that part of the burden at least was due to be passed on to the consumer. Business continues to be very strong in the steel market; in fact, the demand in many directions seems to be expanding, but the works are supplying consumers in urgent need satisfactorily in most instances.

Scrap

Consumers of both iron and steel scrap are hoping to receive the benefit of more imported material in the near future, as home-produced scrap is still far from sufficient to meet the insistent demand. The National Federation of Scrap Iron and Steel Merchants have launched a campaign calculated to produce greater tonnages of scrap for immediate use. The aim is to establish contact with householders, many of whom have valuable metal in their possession which to them serves no useful purpose. The need for procuring scrap at home cannot too strongly be emphasised, as in addition to the higher cost of imported material, the Merchant Service is fully engaged on transporting other commodities which cannot be obtained in the United Kingdom. Through the co-operation of the National Farmers' Union, fields and farmsteads are to be cleared of all surplus metal, which is to be found in large quantities in the shape of ploughs, mowing machines and other agricultural implements which are now of no use. Meanwhile, the campaign of the British Iron and Steel Federation is increasing in strength.

Metals

It is understood that the British Government is to increase its purchases of Empire copper by the purchase of some 50,000 tons from Rhodesia. The price has not yet been decided, but a slightly higher price than that agreed in the original contract may be needed to cover labour costs and increased expenses involved in speeding up production.

The United States market has lately become steadier after the recent easiness. Despite a drop in quotations, consumers showed little disposition to enter the market and forward buying was small. American domestic sales of copper in December were 29,211 short tons, making a total for the year of 803,358 tons, against 514,067 tons in 1938.

The Ministry of Supply has informed the London Metal Exchange that export licences for tin are in future to be granted more freely. It would thus appear that stocks in the United Kingdom have now attained a more satisfactory level than was the case when tin was first included in the Government's control scheme. At the beginning of the war, shipments of ore were not too plentiful, but of late substantial deliveries of Bolivian and other ores have come to hand and smelters have been able to operate freely. Straits tin has been used in large quantities by Continental and American consumers, owing to the difficulties attached to procuring metal from the United Kingdom, but it is expected now that there will shortly be a good demand for exports from this country. Following the announcement with regard to exports, prices in London improved from their recent levels. The British Government will undoubtedly keep a close watch on tin stocks, and exports will continue to be regulated.

Conditions in the United States are summed up in a recent commentary issued by C. S. Trench & Company, Inc., of New York, which states that, "except for the purchase of 500 tons by the Procurement Division of the Treasury Department (early in January), the tin market in New York has been in a quiet condition, and offerings have continued to exceed demands. Consumer indifference indicates that requirements for the first quarter are well covered and that, with the slackening in manufacturing operations, requirements will be less than they were in the last quarter of 1939. For example, tinplate operations are down to about 70 per cent. of capacity, as compared with an average of better than 90 per cent. in the October-December period, and that alone makes a difference of 1,000 tons of tin a month. No sustained upturn in the tinplate trade is looked for before March."

Metal market prices for tin were as follow:—

Cash—Thursday, £234 5s. to £234 10s.; Friday, £236 to £236 10s.; Monday, £238 10s. to £238 15s.; Tuesday, £238 5s. to £238 15s.; Wednesday, £237 to £237 15s.

Three Months—Thursday, £234 5s. to £234 10s.; Friday, £236 to £236 10s.; Monday, £238 10s. to £238 15s.; Tuesday, £238 5s. to £238 15s.; Wednesday, £235 to £235 15s.

Consumers of spelter in the United Kingdom continue to be in the market for substantial tonnages and consumption is fully maintained. Despite a reduction in the American price of spelter from 5.57 to 5.50 cents per lb., East St. Louis the demand is still quiet. Germany is believed to be despatching part of her surplus of g.o.b. spelter to the Soviet Union, but consumption of high-grade metal in Germany continues to be in excess of the available supply.

The more urgent requirements of lead in this country are being met satisfactorily, but there is little available for early despatch to other users.

A Government Order, the Import of Goods (Prohibition) (No. 3) Order, 1940, placing aluminium and certain aluminium products on the list of goods prohibited from importation into the United Kingdom except under licence, will come into force to-day (Thursday).

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